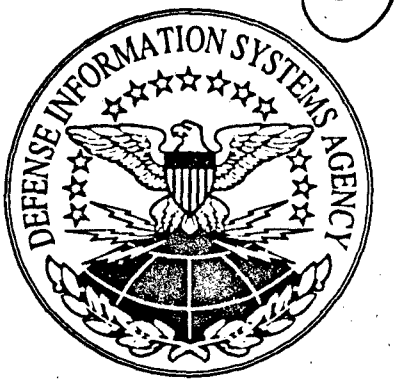

Information Management Functional Economic Analysis for Finance Communications to the Defense Information Technology Services Organization

March 1993

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The document describes the current DoD Finance functional area technical communications baseline, alternatives, and cost analyses that support a recommendation that DoD invest in Ethernet (IEEE 802.3) or token ring (IEEE 802.5) local area networks (LANs) to provide a new technical infrastructure to support the Finance business area. The preferred alternatives require investment in information technology to create a networked end-user computing environment. The investment will improve the productivity of DoD Finance users and provide substantial benefits to DoD.

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EXECUTIVE SUMMARY

This executive summary provides a synopsis of the Information Management Functional Economic Analysis (FEA) for Finance Communications. It is presented in an abbreviated FEA format to provide executive management at all levels with a comprehensive document that contains the essential information required to support the review, approval, and decisionmaking for Finance communications.

This document describes the current Department of Defense (DoD) Finance functional area technical communications baseline, alternatives, and cost analyses that support a recommendation that DoD invest in Ethernet (IEEE 802.3) or token ring (IEEE 802.5) local area networks (LANs) to provide a new technical infrastructure to support the Finance business area. The preferred alternatives require investment in information technology (IT) to create a networked end-user computing environment. The investment will improve the productivity of DoD Finance users and provide substantial benefits to DoD.

The current DoD technical communications baseline consists primarily of point-to-point connections between personal computers (PCs) or 3270-type terminals and host mainframes. These point-to-point connections are limited and inflexible, forcing users to make copies of data and manually transport the data. The existing communications baseline functional activity cost is $26,655 per user over the 7-year life cycle considered in this FEA. This includes personnel costs, hardware and software costs, and operation and maintenance costs.

The three alternative LAN architectures considered in this FEA were drawn from the Finance Communications Guidelines to the Defense Information Technology Services Organization document They are Ethernet, token ring, and Fiber Distributed Data Interface (FDDI). The Ethernet LAN alternative provides the quickest access under low-traffic conditions and has a transmission speed of 10 megabits per second (Mbps). An Ethernet LAN requires an investment of $2,528 per user and provides a total net benefit of $4,031 per user. The token ring LAN alternative provides quicker access under high traffic conditions and has a transmission speed of 16 Mbps. A token ring LAN requires an investment of $2,895 per user and provides a total benefit of $4,283. The FDDI LAN alternative provides a more robust network, low degradation under high traffic, and a transmission speed of 100 Mbps. An FDDI LAN requires an investment of $7,013 per user and provides a total benefit of $1,885 per user.

All three alternatives provide similar benefits. However, the FDDI LAN has a lower Return on Investment than the other two alternatives. Thus, depending on traffic volume, either Ethernet or token ring LANs should be implemented.

Chapter 1

INTRODUCTION

1.1 Introduction

This Information Management Functional Economic Analysis (FEA) for Finance Communications directly supports the policies and guidance presented in the Finance Communications Guidelines to the Defense Information Technology Services Organization (DITSO) document dated 30 November 1992. Originally termed a Technical Economic Analysis (TEA) with a "macro" analysis of technical alternatives, the economic analysis was expanded and termed a technical FEA (with an abbreviated FEA format) and renamed as stated above.

This document parallels three other FEAs that support the following guideline documents:

- Finance Workstation Guidelines to the Defense Information Technology Services Organization
- Client/Server Guidelines to the Defense Information Technology Services Organization
- Finance User Interface Style Guide (3270) to the Defense Information Technology Services Organization

This particular FEA addresses local area network (LAN) communications and helps determine the cost effectiveness of transitioning to a networked end-user computing environment.

1.2 Purpose

This FEA compares the costs to the Finance functional area for each of three types of LAN with a baseline environment (without an installed LAN). Based on guidance provided in the Finance Communications Guidelines to the Defense Information Technology Services Organization, the following LAN topology access methods are examined:

- Ethernet
- Token ring
- Fiber Distributed Data Interface (FDDI)

1.3 Scope

The scope of this analysis is limited to the economic analysis of technological alternatives to the Finance technical infrastructure. While it is recognized that the functions, systems, and organization are all affected by changes in technology, for the purposes of this analysis they remain constant. However, functional improvements such as increased productivity that result directly from technological enhancements will be considered in the analysis. Secondary effects (such as hiring or termination costs) are excluded from the scope of this analysis.

Cross-functionality of the equipment and capabilities addressed in this FEA must be considered in developing a true picture of the total package of recommended options. Functional managers must determine the full range of performance requirements as well as the capabilities various equipment must possess. This should be done in coordination with other functional areas where users may eventually employ the same equipment or share equipment on a fee-for-service basis. An equitable method of spreading these costs across other functional areas may be required in cases where, for example, another functional area uses the Finance LAN.

1.4 Methodology

A technical FEA examines current and proposed technical architectures and expected financial results prior to the decision to invest in any new technologies. It quantifies technical costs, benefits, and risks, and adjusts the dollar amounts to account for the time value of money.

A FEA allows the current and forecasted costs of baseline operations over a stated economic life to be compared to alternatives associated with management initiatives. Sunk costs are not included in an FEA. The technical FEA applies to decisions involving proposed and existing technology. It provides support for and input to the decisionmaking process by comparing investment in various alternatives to a baseline. Each alternative is defined as a technology change leading to potential cost savings.

The Draft Department of Defense (DoD) 8020.1-M, Functional Process Improvement Manual, establishes eight sections that must be completed for a FEA:

- Section 1: Functional Area Strategic Plan
- Section 2: Functional Activity Strategic Plan
- Section 3: Functional Activity Performance Measures and Targets
- Section 4: Proposed Functional Activity Improvement Program
- Section 5: Economic Analysis of the Proposed Process Improvement Program

- Section 6: Data Management and Information Systems Strategy for the Functional Activity
- Section 7: Data and Systems Changes to Support the Functional Activity Improvement Programs
- Section 8: Data Management and System Cost Analysis

This technical FEA concentrates on section 5, the economic analysis of the technological alternatives. Although a full FEA would require an analysis of all the process improvements, this one deals with process improvements that are directly linked to new technology. The main objective for this task was the analysis of section 5. Therefore, the remaining seven FEA sections were not completed.

A technical FEA is developed and iteratively refined as follows:

- Determine scope of technical area
- Identify existing baseline technology
- Gather baseline costs
- Determine technical alternatives
- Perform financial simulations
- Analyze and make recommendations

To present the quantitative data necessary to support the decision to invest in new technology, the baseline costs of Finance communications were gathered. Life cycle costs of continuing Finance operations were forecasted in budget-year dollars over a 7-year economic period. These costs were gathered and modeled in five technical FEA cost categories:

- Personnel
- Information technology (IT) hardware
- IT software
- IT operation and maintenance (O&M)
- Other (facilities, materiel, training, etc.)

In order to perform this FEA responsively, a model and set of spreadsheet tools were developed for compiling cost-benefit data for the baseline and selected alternatives. As noted above, costs are depicted in budget-year dollars. However, the completed analysis requires a calculation of Return on Investment (ROI), which is calculated from discounted or present-value cash flows rather than from budget-year values themselves. The tools perform risk-adjusted present-value comparisons and compute the ROI using discount factors.

The assessment of risk in a proposed project or alternative is perhaps the most difficult and yet most critical task that faces managers charged with decisionmaking. Risk analysis attempts to account for underlying forecast error. Placed in financial terms, risk analysis allows senior managers to compare the potential advantages of a proposed alternative balanced against the

chances that the predicted outcomes may not occur. The analytical methodology used to quantify and describe risk in this FEA employs a lognormal probability density function to model the risks, as directed by the most current FEA guidelines.

The analysis is performed at a macro level and includes several assumptions about the rest of the migration technical environment in order to separate the focus and scope of the FEAs. If the Finance community wishes to pursue the alternatives in this analysis, it should first confirm the assumptions.

Specific information about the actual functions performed by particular Finance users was not available for this FEA. Aggregate user activity profiles generated by the Gartner Group were used for analysis purposes in this FEA. While the aggregate user activity profile will not be accurate when compared to a particular Finance user, it may be applied to the Finance community as a whole. A precise functional activity profile could be determined through a full FEA of the Finance community.

1.5 Document Organization

The remainder of this document is organized as follows. Chapter 2 discusses the existing technical baseline and the costs associated with it. Chapter 3 presents the assumptions used in this analysis and discusses the technical alternatives. Chapter 4 presents the investment costs and benefits associated with each of the alternatives presented in chapter 3. Chapter 5 presents the analysis of the risks associated with each of the alternatives, and presents the recommendations.

Appendix A provides acronym definitions. Appendix B provides a list of references. Appendix C details the recurring costs for the baseline and the three alternatives. Appendix D details the investment costs for each of the three alternatives. Appendix E includes exhibits detailing per-user and total baseline communications costs; the per-user and total costs for the Ethernet, token ring, and FDDI alternatives; and the risk profile for the baseline and alternatives.

Chapter 2

BASELINE

This chapter discusses the technology used in the current baseline and the enterprise costs associated with that technology. Costs are given for the base year, FY 1994, unless otherwise stated. Costs are not equal to the average cost per year across the life cycle, due to inflation.

2.1 Baseline Technology

The technical baseline or current environment is composed primarily of stand-alone personal computers and 3270-type terminals connected to host computers through dial-in modems and/or direct point-to-point networks. Although a limited number of small LANs exists within the Finance functional area, for the purposes of this analysis the technical baseline does not include use of a LAN.

2.2 Baseline Costs

Total baseline costs are $3,380 per user (for the base year) and $26,655 over the life cycle. The baseline includes recurring costs for personnel and maintenance. The baseline has personnel costs of $3,370 for each user ($26,577 over the life cycle). No hardware, software, or other costs are associated with the current technical baseline. The technical baseline base-year annual maintenance costs were estimated to be $10 per user ($78 over the life cycle), based on a share of the overall hardware maintenance requirement. For further details about enterprise costs, refer to appendix C.

Chapter 3

ALTERNATIVES

3.1 Local Area Network Access Methods and Basic Components

This chapter discusses the underlying assumptions, based on the Finance Communications Guidelines, that were used in formulating alternatives to the baseline.

In considering a LAN topology, the question of access method arises. The access method is used to carry out a number of fundamental network processes, which function to guarantee the error-free delivery of information between systems. Most LANs use distributed access methods in which each workstation participates equally in controlling the network. The two general classes of distributed access are contention and deterministic. In a contention scheme, any station can initiate a transmission at any time. In a deterministic access method, each station must wait its turn to transmit; the access method is designed to manage the sequential allocation of network transmission resources.

Each LAN component has a specific function and affects the overall performance of the system. On every distributed or client/server network, each workstation requires access to the file server. It typically is not possible or economically feasible for each workstation to have its own cable connected directly to the server, so a hub or concentrator is used. The hub becomes a junction point at which several workstations can make the connection with the server.

The choice of cabling method can have a major impact on the choice of network topology. Alternatively, facilities may be wired for some type of data terminals, and it may be desirable to maintain the existing wiring scheme. It is important that LAN cabling be done correctly the first time. Most new LAN cabling plant installations use twisted pair wiring, one of the lowest cost media available. Twisted pair wiring is available in either shielded (STP) or unshielded (UTP) versions. UTP is the most popular version, resembling and often identical to standard telephone systems. STP adds an aluminum shield around the wire to increase protection against electromagnetic interference and to provide greater cabling distances. The other major cabling medium uses fiber optics. Glass fiber delivers extremely high speeds but is relatively difficult to install and maintain. Although many existing LANs use coaxial cabling, its importance is diminishing rapidly. Coaxial cabling will continue to be supported for some time but it is more expensive than twisted pair and does not offer channel speeds comparable to fiber.

Other key LAN components include gateways, routers, bridges, and repeaters. Details are as follows.

Gateways - Often described as application layer devices and frequently link devices that do not share a common data alphabet or signaling system.

Routers - Sophisticated internetworks have created the demand for more intelligent devices between networks. Since routers only forward packets of information that are specifically addressed to a known network address, routers can reduce the volume of extraneous traffic across internetwork links and can make more efficient use of long distance and/or other expensive communications links.

Bridges - One of the most common methods of interconnecting LANs across different segments, whether the LAN is local or remote.

Repeaters - Operate at the physical layer of the Open Systems Interconnection (OSI) model by simply repeating all the traffic that passes from one LAN segment to another. They are used most often to extend the length of a particular LAN segment beyond the normal distances of a particular LAN medium.

All or only specific components may be used in a LAN, depending on the functional requirement. The following LAN alternatives to the non-LAN baseline are addressed in this FEA:

- Ethernet LAN (IEEE 802.3)
- Token ring LAN (IEEE 802.5)
- FDDI LAN (ANSI X3T9.5)

3.2 Assumptions

The LANs will be designed in a star architecture with intelligent concentrator hubs as the center points. Concentrator hubs will be of modular design and will provide gateway, routing, and bridging functions. The hubs will support twisted pair and fiber optic cable.

Standard network nodes (workstations, file servers, etc.) will be wired to the hubs by either unshielded or shielded twisted pair wire, in compliance with IEEE standards. Fiber will be used to support those network nodes where security, bandwidth, and environmental parameters are of concern. Hubs will be interconnected by fiber optic cable.

Gateways, routers, bridges, and repeaters will be used within the LAN where necessary. These devices will support multiple protocols, where applicable, and will be provided by vendors who are committed to OSI compliance, including all applicable IEEE 802.1 standards.

The LAN will be supported by a UNIX-based network operating system and Transmission Control Protocol/Internetwork Protocol (TCP/IP) for communications. The UNIX-TCP/IP solution offers optimum network interconnectivity and provides an efficient migration path toward a future Open Systems Environment (OSE).

The LAN will provide file, printer, data backup, disk access, facsimile, and communications services.

A wide range of assumptions is required in order to estimate the costs associated with the baseline and alternatives. These assumptions led to the information included in the spreadsheets.

The targeted communications alternatives presented in this analysis should be considered as a near-term solution. Networks such as those considered here become technically obsolete after 6 years. Nonetheless, these communications alternatives provide a new technical infrastructure to support long-term DoD and Federal objectives. In addition, the communications alternatives provide functional capabilities that are not present in the baseline or that would be prohibitively expensive to perform using baseline technology.

It is assumed that the following migration technical environment will exist:

- Workstations - A workstation exists for each user.
- Client/server - The network will support 3270-type terminal functionality; application and data server connectivity will be required.
- User interface - A common user interface is used, and graphical user interface (GUI) services are available through MS Windows or equivalent.

It is assumed that the Finance users must be able to perform their current tasks on the 3270-type terminals or PCs. In addition, a 2-year delay is expected before the typical user realizes the full benefit provided by new technology.

The assumptions and constraints underlying the overall analysis and modeling of the economic activity of the Finance enterprise are as follows:

- All costs and benefits are presented for the five technical FEA cost categories:
  - Personnel
  - IT hardware
  - IT software
  - IT O&M
  - Other (facilities, materiel, training, etc.)
- Benefits are reductions from baseline costs. All costs affected by Finance operations have been included as baseline costs in this FEA. Benefits are phased in over a 2-year period, which represents the learning curve of new technology.
- FEA costs are generally gathered and modeled for the base year and then appropriate growth rates are applied to forecast the costs for the remainder of the life cycle.

- This technical FEA uses FY 1994 as the base year. The analysis is for a 7-year period, which includes both a planning phase and a residual period. The planning phase for this FEA is 4 years, with the residual accounting for the remaining 3 years. The planning phase represents the economic life of the new technology. All graphs cover a 4-year timeframe beginning in FY 1994 and ending in FY 1997.

- All costs and benefits are in budget-year dollars, which include nominal growth (inflation and real growth). The source for the inflators is the Office of the Secretary of Defense (Comptroller) (OSD (C)). The inflation rates for each FEA cost category are as follows:

Cost Category	Type	Rate (Percent)
Personnel	Outlays - Military Personnel	3.95
IT Hardware	DoD Information Rate	12.00
IT Software	DoD Information Rate	12.00
IT O&M	Outlays - O&M	3.70
Other (Training)	Outlays - Military Personnel	3.95

  According to the Bureau of Labor Statistics, there are no real growth rates in the cost categories in this FEA. Since the nominal growth rates are found by multiplying the real growth rate by the appropriate inflator, the nominal rates are the same as the inflation rates.

- To compute the ROI and present value, the model uses a 7 percent mid-year discount factor as provided in the Office of Management and Budget Guidance, Circular A94 (Revised).

- All costs are defined on a per-user basis, and both costs and benefits are scalable unless noted otherwise.

- All alternatives are deployed in FY 1994, but the maximum benefits are not realized until FY 1996. Only 20 percent of the maximum benefit is realized in FY 1994, while 80 percent of the maximum benefit is realized in FY 1995.

3.3 Ethernet LAN

An Ethernet LAN uses a contention-based, nondeterministic access method. All stations can sense whether another station is transmitting. Each station waits until the channel is open before attempting to transmit. If two stations transmit simultaneously, a "collision" occurs; both stations immediately stop transmitting and each waits a random length of time before attempting to transmit again. An Ethernet network is generally suitable for networks with many users who generate relatively little network traffic over long time spans. Ethernet has a bandwidth capacity of 10 megabits per second (Mbps) and provides quick access to the network. Ethernet has a

logical limit of 1,000 users for each segment. However, Ethernet segments can be joined together into internetworks to connect larger numbers of workstations. High traffic volumes can rapidly degrade network performance due to collisions, retransmissions, and collisions of retransmissions.

3.4 Token Ring LAN

A token ring LAN uses a deterministic access method in which the right to transmit is distributed by passing a "token" from station to station. A workstation must first acquire the token before transmitting; it then passes the token to the next station. Token passing is done through polling. Token ring provides much steadier performance under heavy traffic conditions than does Ethernet. Token ring networks are most suitable for sites with relatively few users who require more extensive communications resources. Larger token rings do bog down under the weight of heavy network traffic, however, as tokens become more scarce for each network user.

3.5 FDDI LAN

An FDDI LAN uses an access method for high-speed, high-bandwidth fiber optic cable. FDDI uses token passing for access to two rings: a primary ring and a secondary ring. Normally, traffic runs on the primary ring; if there is a fault in the primary ring, then traffic is switched to the secondary ring. FDDI is suitable for high-security installations because of its lack of electromagnetic interference/radio frequency interference (EMI/RFI) emissions and its resistance to being physically tapped without detection. It is also suitable for LANs that support imaging, multimedia, and electronic data interchange (EDI). Although FDDI is more robust and secure than Ethernet or token ring, it is also significantly more expensive.

Chapter 4

BENEFITS

This section discusses the benefits provided by the alternative networks over the unnetworked baseline.

4.1 Ethernet LAN

An Ethernet LAN provides the ability to share applications, resources, and data among users on the network. Data can be shared among and distributed to other users of the network, reducing the need to manually transport and copy data.

An Ethernet LAN provides benefits in user productivity. The Ethernet LAN provides the user with the ability to transfer data between computers. Electronic mail and network software allow users to send files to other users and directly access files on other computers. Less time is spent preparing data for sending and transporting data from computer to computer or from user to user.

The Ethernet alternative requires an investment of $2,528 per user in budget-year dollars over the full life cycle. This investment includes $1,290 in hardware costs, $300 in software costs, and $938 in maintenance costs. Additional details on the investment costs are included in appendix D.

The Finance community will realize benefits as a result of this investment. (Benefits are defined as the difference between the selected alternative and the baseline.) A total of $4,031 in net benefits (including investment costs) per user is expected as a result of implementing the Ethernet alternative over the full life cycle. Benefits are realized in every cost category except IT software. The total benefit of $6,947 over the life cycle is expected in the personnel area, which is realized from the increased productivity provided by the Ethernet LAN. The baseline hardware is sold, so both the hardware salvage value ($50) and the O&M costs associated with the baseline ($78) are classified as benefits for this alternative. The remaining $517 is a negative benefit representing the increased training costs that are necessary for the implementation of this alternative. The following table summarizes these costs and benefits. Additional discussion of the benefits is included in appendix C.

Ethernet Benefits	
Personnel	$6,947.3
IT Hardware	50.0
IT Software	0.0
IT O&M	78.2
Other	(516.7)
Gross Benefits	$6,558.8
IT Hardware Investment	(1,290.0)
IT Software Investment	(300.0)
IT O&M Investment	(938.2)
Net Benefits	$4,030.6

4.2 Token Ring LAN

A token ring LAN provides the same functionality as an Ethernet LAN, and similar benefits can be realized through the implementation of a token ring LAN. A token ring LAN is 60 percent faster than an Ethernet LAN, moving data at 16 Mbps instead of 10 Mbps.

A token ring LAN provides benefits in user productivity. Like the Ethernet LAN, the token ring LAN provides the user with the ability to transfer data between computers. Electronic mail and network software allow users to send files to other users and directly access files on other computers. Less time is spent preparing data for sending and transporting data from computer to computer or from user to user.

The token ring alternative requires an investment of $2,895 per user in budget-year dollars over the full life cycle. This investment is composed of $1,500 in hardware costs, $300 in software costs, and $1,095 in maintenance costs. Additional details on the investment costs are included in appendix D.

The Finance community will realize benefits as a result of this investment. A total of $4,283 in net benefits (including investment costs) per user is expected as a result of implementation of the token ring alternative over the full life cycle. Benefits are realized in every cost category except IT software. Total benefits of $7,566 over the life cycle are expected in the personnel area, which are realized from the increased productivity provided by the token ring LAN. The baseline hardware is sold, so both the hardware salvage value ($50) and the O&M costs

associated with the baseline ($78) are classified as benefits for this alternative. The remaining $517 is a negative benefit representing the increased training costs that are necessary for the implementation of this alternative. The following table summarizes these costs and benefits. Additional discussion of the benefits is included in appendix C.

Token Ring Benefits

Personnel	$7,566.2
IT Hardware	50.0
IT Software	0.0
IT O&M	78.2
Other	(516.7)
Gross Benefits	$7,177.7
IT Hardware Investment	(1,500.0)
IT Software Investment	(300.0)
IT O&M Investment	(1,094.5)
Net Benefits	$4,283.2

4.3 FDDI LAN

An FDDI LAN provides the same functionality as an Ethernet or token ring LAN, but has much higher speed (6 to 10 times faster) and capacity.

An FDDI LAN has the highest potential benefits in user productivity. Like the other LAN alternatives, the FDDI LAN provides the user with the ability to transfer data between computers. Electronic mail and network software allow users to send files to other users and to access files on other computers. Because FDDI has such high bandwidth and speed, much less time is required when sending and transporting data from computer to computer or from user to user. This allows much larger files to be sent more often, supporting multimedia or imaging applications.

The FDDI alternative requires an investment of $7,013 per user in budget-year dollars over the full life cycle. This investment includes $3,820 in hardware costs, $300 in software costs, and $2,893 in maintenance costs. Additional details on the investment costs are included in appendix D.

The Finance community will realize benefits as a result of this investment. A total of $1,885 n net benefits (including investment costs) per user is expected as a result of implementation of the FDDI alternative over the full life cycle. Benefits are realized in every cost category except IT software. The total of $9,286 over the life cycle is expected in the personnel area, which is realized from the increased productivity provided by the FDDI LAN. The baseline hardware is sold, so both the hardware salvage value ($50) and the O&M costs associated with the baseline ($78) are classified as benefits for this alternative. The remaining $517 is a negative benefit representing the increased training costs that are necessary for the implementation of this alternative. The following table summarizes these costs and benefits. Additional discussion of the benefits is included in appendix C.

FDDI Benefits

Personnel	$9,285.9
IT Hardware	50.0
IT Software	0.0
IT O&M	78.2
Other	(516.7)
Gross Benefits	$8,897.4
IT Hardware Investment	(3,820.0)
IT Software Investment	(300.0)
IT O&M Investment	(2,892.7)
Net Benefits	$1,884.7

Chapter 5

ANALYSIS AND RECOMMENDATIONS

This chapter presents overall conclusions and recommendations based on the analysis performed for this FEA. It discusses the risk analysis that was performed, the analysis results, and the final comments.

5.1 Risk Analysis

The following sections describe the risk profiles that were applied to the baseline and various alternatives. According to *The Business Value of Computers* by Paul Strassmann, risk identifies both the potential advantages of information technology investments and the chances that predicted outcomes may not materialize. The risk profiles classify the level of risk for each of the various alternatives. The profiles provide endpoints that define the best possible cost outcome, as well as the worst, for each technology investment. The risk profiles are included in appendix E.

5.1.1 BASELINE

The baseline is considered to have low risk since it is well established within the Finance functional area. However, if the Finance user community is expected to operate its business more efficiently, it will need to incorporate new technologies. If it does not, then the Finance functional area runs the risk of increasing its current operating costs in order to remain competitive.

The baseline risk is represented by a lognormal distribution with a low-end equivalent of 0.9 of the expected cost, and a high end capped at 1.22 of the expected cost. In probability terms, the distribution is identified to be within 25 percent of a standard deviation on the low end and within 50 percent of a standard deviation on the high end. Baseline costs are expected to be as forecast through the analysis, but costs could range from 10 percent below the expected to 22 percent above the expected.

5.1.2 ETHERNET LAN

An Ethernet LAN is considered less risky than the other alternatives because it is the most common form of LAN. The risk is represented by a lognormal distribution with a low-end equivalent of 0.9 of the expected cost, and a high end capped at 1.43 of the expected cost. In probability terms, the distribution is identified to be within 25 percent of a standard deviation

on the low end and within a standard deviation on the high end. This means the Ethernet LAN costs may range from 10 percent below to 43 percent above the analysis results.

5.1.3 TOKEN RING LAN

The risk for the token ring alternative is slightly larger than the risk for the Ethernet alternative because it is not as commonly installed. The risk is a lognormal distribution with a low-end equivalent of 0.9 of the expected cost, and a high end capped at 1.65 of the expected cost. In probability terms, the distribution is identified to be within 25 percent of a standard deviation on the low end and within 1.5 standard deviations on the high end. This means the token ring LAN costs may range from 10 percent below to 65 percent above the analysis results.

5.1.4 FDDI LAN

The FDDI alternative has greater risk than either of the other alternatives because it is relatively new, so there is little experience with FDDI LANs. The risk is a lognormal distribution with a low-end equivalent of 0.9 of the expected cost, and a high end capped at 1.86 of the expected cost. In probability terms, the distribution is identified to be within 25 percent of a standard deviation on the low end and within 2 standard deviations on the high end. This means that the FDDI LAN costs may range from 10 percent below to 86 percent above the analysis results.

5.2 Analysis Summary

This section summarizes the cost analysis of the baseline and alternatives presented in the FEA. The costs of the alternatives are compared to the baseline and to each other. Expected benefits are summarized. The ROI for each alternative is presented. Finally, the distribution of investment return is presented and analyzed as it relates to the risk analysis associated with each alternative.

5.2.1 COST COMPARISON FOR BASELINE AND THREE ALTERNATIVES

Exhibit 5-1 shows the total expected costs for the baseline and three alternatives at a summary level. The low, expected, and high costs over the entire life cycle are shown in exhibit 5-2. As can be seen from these exhibits, the Ethernet and token ring LANs have the lowest costs. Both of these alternatives offer substantial benefits over the present baseline. The FDDI LAN offers costs that are lower than the baseline, but about 10 percent greater than the other two alternatives.

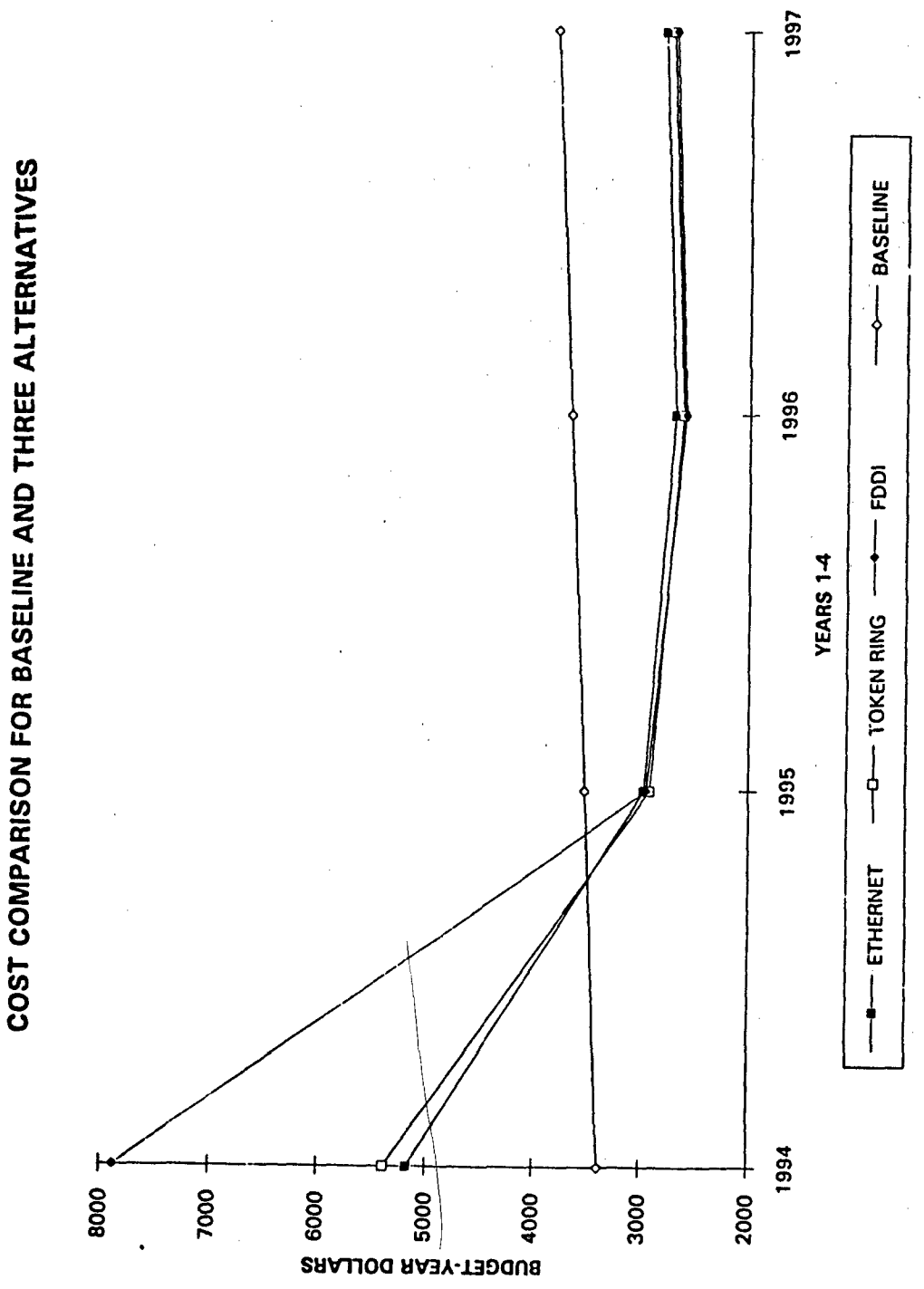
COST COMPARISON FOR BASELINE AND THREE ALTERNATIVES
BUDGET-YEAR DOLLARS
8000
7000
6000
5000
4000
3000
2000
1994
1995
1996
1997
YEARS 1-4
ETHERNET
TOKEN RING
FDDI
BASELINE

Exhibit 5-1

FINANCE COMMUNICATIONS COSTS
BUDGET-YEAR DOLLARS

		1994	1995	1996	1997	RESIDUAL	TOTAL
BASELINE	LOW	3,042.0	3,162.1	3,287.0	3,416.8	11,081.6	23,989.6
	EXPECTED	3,380.0	3,513.5	3,652.2	3,796.5	12,312.9	26,655.1
	HIGH	4,106.7	4,268.9	4,437.5	4,612.7	14,960.2	32,386.0
ETHERNET:	LOW	4,653.0	2,666.0	2,411.2	2,506.1	8,125.8	20,362.1
	EXPECTED	5,170.0	2,962.2	2,679.1	2,784.5	9,028.7	22,624.5
	HIGH	7,393.1	4,236.0	3,831.1	3,981.9	12,911.0	32,353.1
TOKEN RING	LOW	4,842.0	2,619.2	2,343.0	2,435.1	7,895.4	20,134.7
	EXPECTED	5,380.0	2,910.2	2,603.3	2,705.7	8,772.7	22,371.9
	HIGH	8,850.1	4,787.3	4,282.5	4,450.9	14,431.0	36,801.8
FDDI	LOW	7,092.0	2,646.7	2,322.3	2,413.0	7,819.4	22,293.4
	EXPECTED	7,880.0	2,940.7	2,580.3	2,681.1	8,688.3	24,770.5
	HIGH	14,656.8	5,469.8	4,799.4	4,986.9	16,160.2	46,073.1

Exhibit 5-2

5.2.2 BENEFIT COMPARISON OF THREE ALTERNATIVES

Exhibit 5-3 shows the total expected benefits for the three alternatives at a summary level. Exhibit 5-4 shows these values (low, expected, and high) by year over the entire life cycle. From the cost comparisons to the baseline above, the Ethernet and token ring alternatives offer the greatest expected benefit, $4,031 and $4,283 respectively, compared to the baseline.

Exhibit 5-5 shows the total expected cumulative benefits for the three alternatives at the summary level. Exhibit 5-6 shows these expected values by year over the entire life cycle. As illustrated by this exhibit, the Ethernet and token ring alternatives offer the greatest cumulative benefits and the earliest payback period, FY 1997. The FDDI LAN results in negative cumulative benefits during the planning phase, but offers $1,885 in cumulative benefits by the end of the residual period.

5.2.3 RETURN ON INVESTMENT

Exhibit 5-7 provides a summary of expected costs, benefits, and ROI for each of these alternatives. The top portion of the exhibit presents total costs, investment, and expected benefits in budget-year dollars over the full life cycle, The lower portion of the exhibit, entitled Return on Investment, presents the ROI calculation. The calculation of the ROI requires conversion of dollar values to a discounted, or present value, form.

The ROI is defined as the baseline cost minus the alternative cost divided by the investment cost. The alternative cost includes the investment for that alternative. Thus, the resulting benefit is a net value.

The expected ROI for both the Ethernet and token ring LANs is quite significant, 114 percent and 105 percent respectively. As expected, the FDDI alternative results in a small ROI of 6 percent.

5.2.4 DISTRIBUTION OF INVESTMENT RETURN

Determining the distribution of expected investment return is the final process in the analysis methodology that links baseline, alternative, benefits, and ROI. The underlying risk assessment that was constructed for each alternative now interacts with the expected ROI to provide a probability distribution of the investment return. Exhibits 5-8, 5-9, and 5-10 show the distribution of investment return for each of the alternatives.

As explained in section 5.2.3, the model calculates ROI as the quotient of the baseline discounted cost minus the alternative discounted cost (including investment) divided by the alternative discounted investment. Each risk profile provides 20 cost multipliers that, when multiplied by the total baseline or alternative cost, define a range of possible costs. The ROI calculation is performed for every possible combination of these derived cost multipliers for the

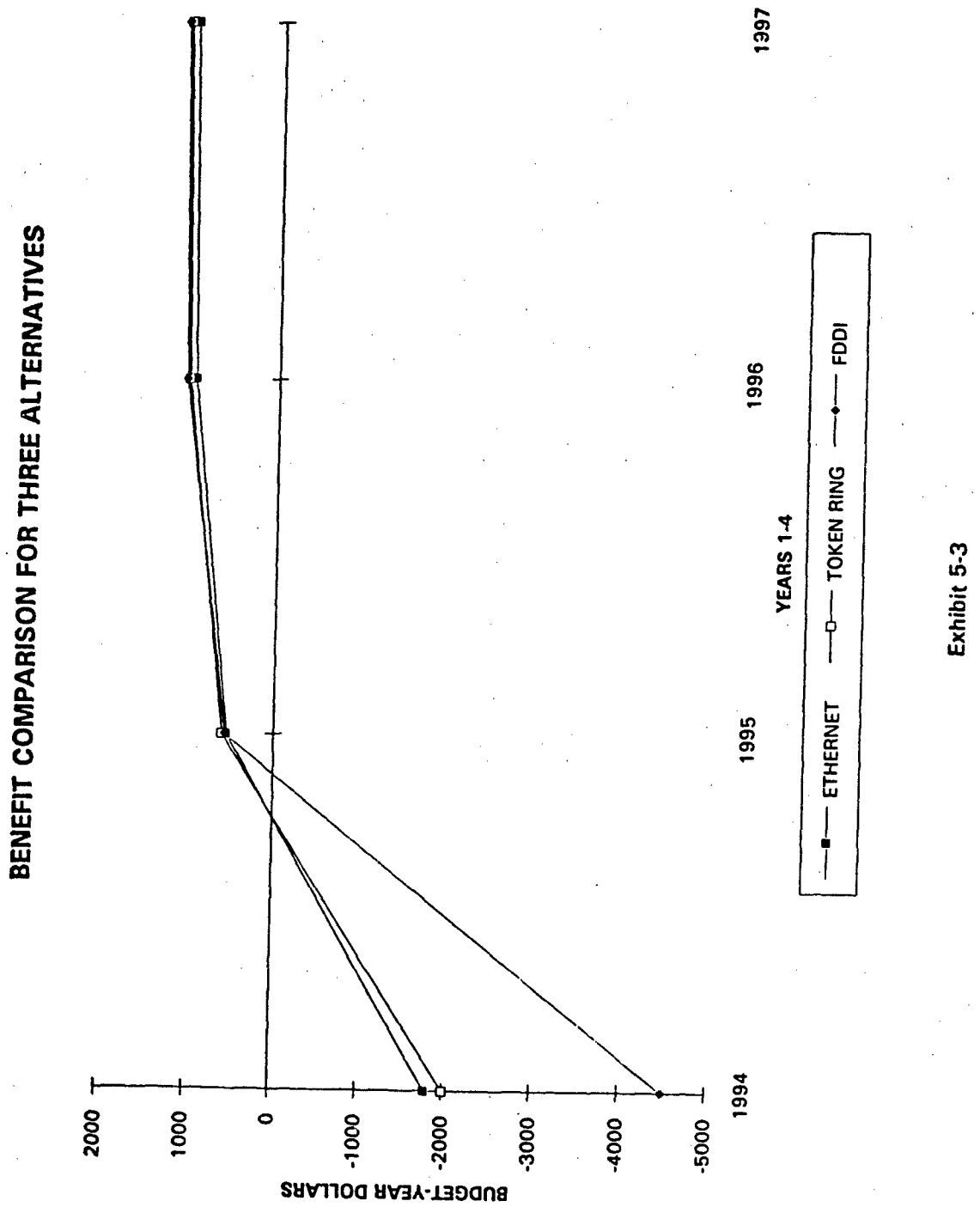
BENEFIT COMPARISON FOR THREE ALTERNATIVES
BUDGET-YEAR DOLLARS
2000
1000
0
-1000
-2000
-3000
-4000
-5000
1994
1995
1996
1997
YEARS 1-4
ETHERNET
TOKEN RING
FDDI

Exhibit 5-3

FINANCE COMMUNICATIONS BENEFITS
BUDGET-YEAR DOLLARS

		1994	1995	1996	1997	RESIDUAL	TOTAL
ETHERNET:	LOW	-1,611.0	496.1	875.8	910.7	2,955.8	3,627.5
	EXPECTED	-1,790.0	551 3	973.2	1,011.9	3,284.2	4,030.6
	HIGH	-2,559.7	788.3	1,391.6	1,447.1	4,696.5	5,763.7
TOKEN RING:	LOW	-1,800.0	543.0	944.0	981.7	3,186.2	3,854.9
	EXPECTED	-2,000.0	603.3	1,048.9	1,090.8	3,540.3	4,283.2
	HIGH	-3,290.0	992.4	1,725.5	1,794.3	5,823.7	7,045.9
FDDI:	LOW	-4,050.0	515.5	964.7	1,003.8	3,262.2	1,696.2
	EXPECTED	-4,500.0	572.8	1,071.9	1,115.3	3,624.7	1,884.7
	HIGH	-8,370.0	1,065.3	1,993.7	2,074.5	6,741.9	3,505.5

Exhibit 5-4

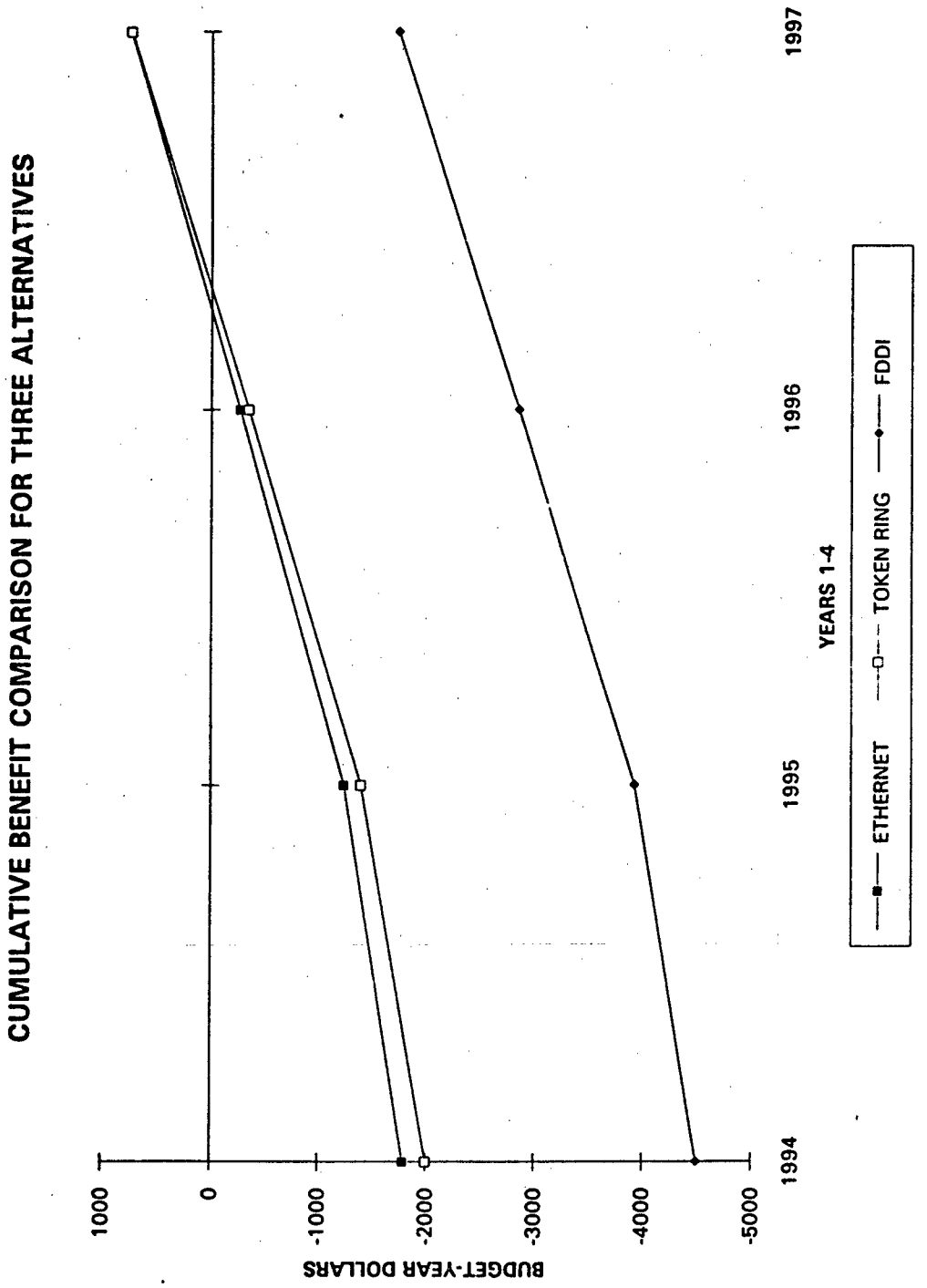
CUMULATIVE BENEFIT COMPARISON FOR THREE ALTERNATIVES
BUDGET-YEAR DOLLARS
1000
0
-1000
-2000
-3000
-4000
-5000
1994
1995
1996
1997
YEARS 1-4
ETHERNET
TOKEN RING
FDDI

Exhibit 5-5

FINANCE COMMUNICATIONS CUMULATIVE BENEFITS
BUDGET-YEAR DOLLARS

		1994	1995	1996	1997	RESIDUAL
ETHERNET:	EXPECTED	-1,790.0	-1,238.7	-265.6	746.3	4,030.6
TOKEN RING:	EXPECTED	-2,000.0	-1,396.7	-347.8	743.0	4,283.2
FDDI:	EXPECTED	-4,500.0	-3,927.2	-2,855.3	-1,740.0	1,884.7

Exhibit 5-6

SUMMARY OF EXPECTED COSTS AND BENEFITS
FY 1994 - FY 2000

BUDGET-YEAR DOLLARS

ALTERNATIVE	EXPECTED INVESTMENT	EXPECTED COSTS	EXPECTED NET BENEFITS
BASELINE	N/A	26,655.1	N/A
ETHERNET	2,528.2	22,624.5	4,030.6
TOKEN RING	2,894.5	22,371.9	4,283.2
FDDI	7,012.7	24,770.5	1,884.7

SUMMARY OF RETURN ON INVESTMENT
FY 1994 - FY 2000

DISCOUNTED DOLLARS

ALTERNATIVE	EXPECTED INVESTMENT	EXPECTED COSTS	EXPECTED NET BENEFITS	EXPECTED ROI %
BASELINE	N/A	20,752.4	N/A	N/A
ETHERNET	2,269.0	18,170.9	2,691.9	113.8%
TOKEN RING	2,593.9	18,029.7	2,860.6	105.0%
FDDI	6,239.1	20,380.4	1,258.7	6.0%

Exhibit 5-7

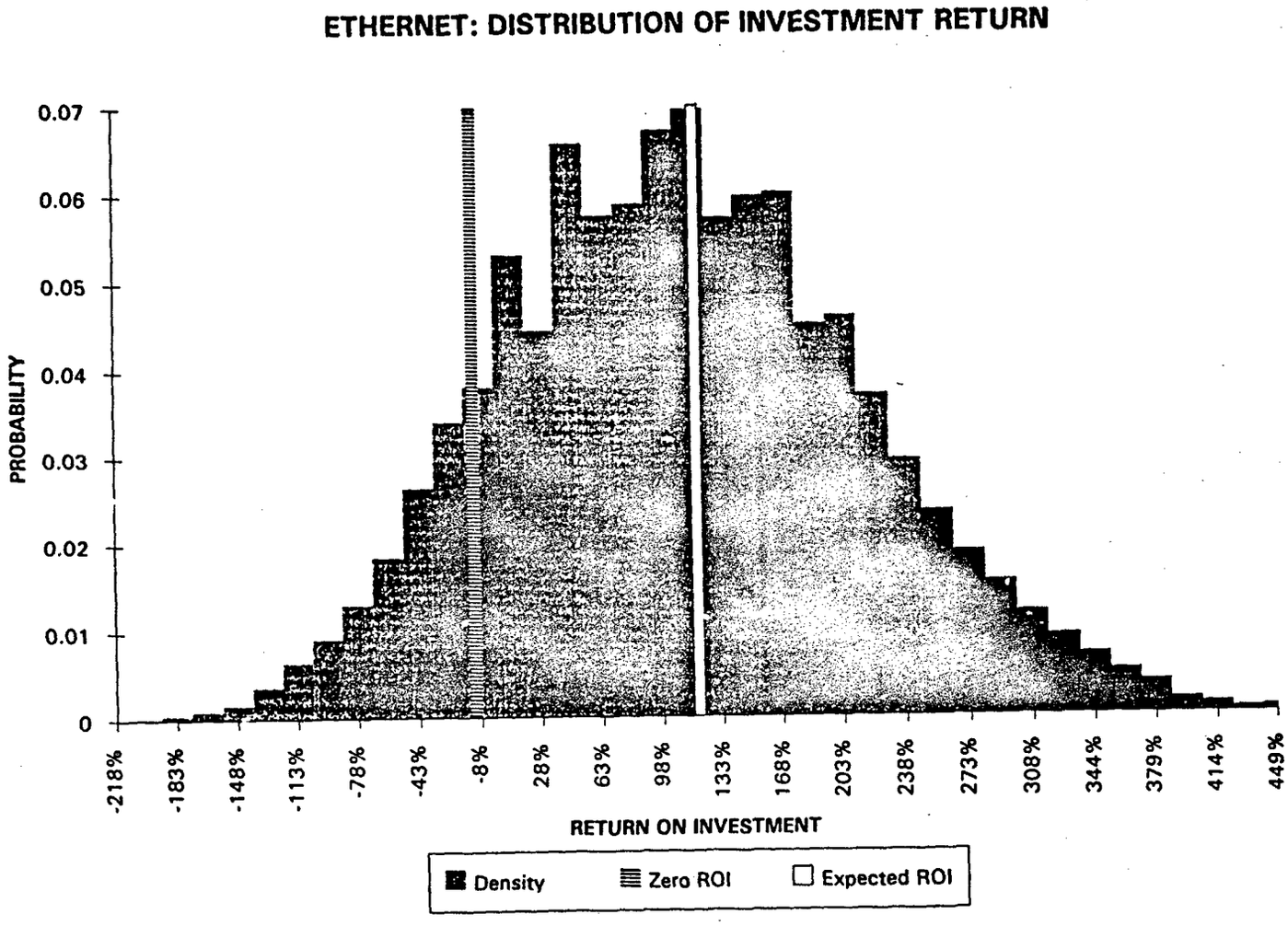
ETHERNET: DISTRIBUTION OF INVESTMENT RETURN
PROBABILITY
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
-218%
-183%
-148%
-113%
-78%
-43%
-8%
28%
63%
98%
133%
168%
203%
238%
273%
308%
344%
379%
414%
449%
RETURN ON INVESTMENT
Density
Zero ROI
Expected ROI

Exhibit 5-8

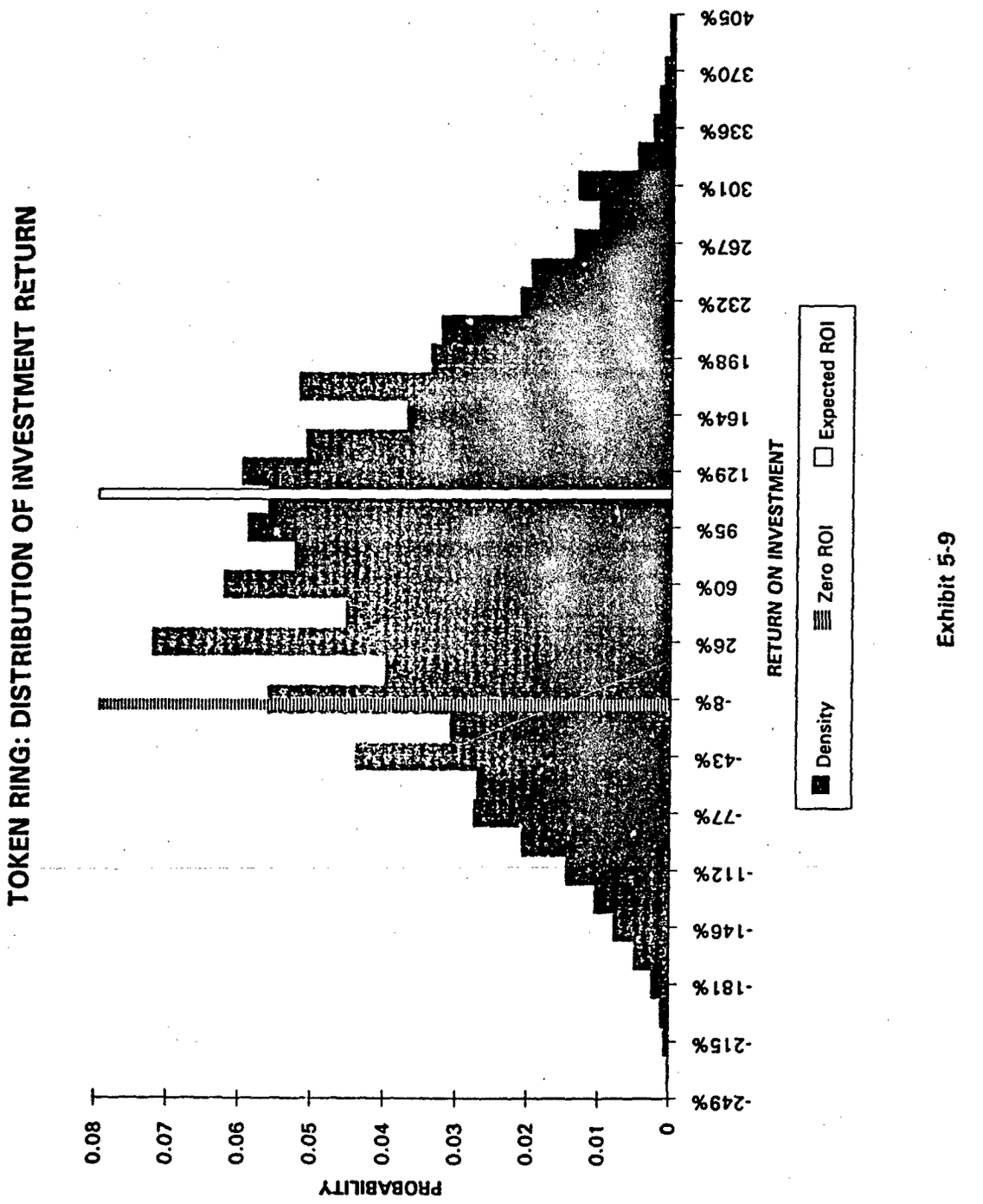
TOKEN RING: DISTRIBUTION OF INVESTMENT RETURN
PROBABILITY
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
RETURN ON INVESTMENT
-249%
-215%
-181%
-146%
-112%
-77%
-43%
-8%
26%
60%
95%
129%
164%
198%
232%
267%
301%
336%
370%
405%
Density
Zero ROI
Expected ROI

Exhibit 5-9

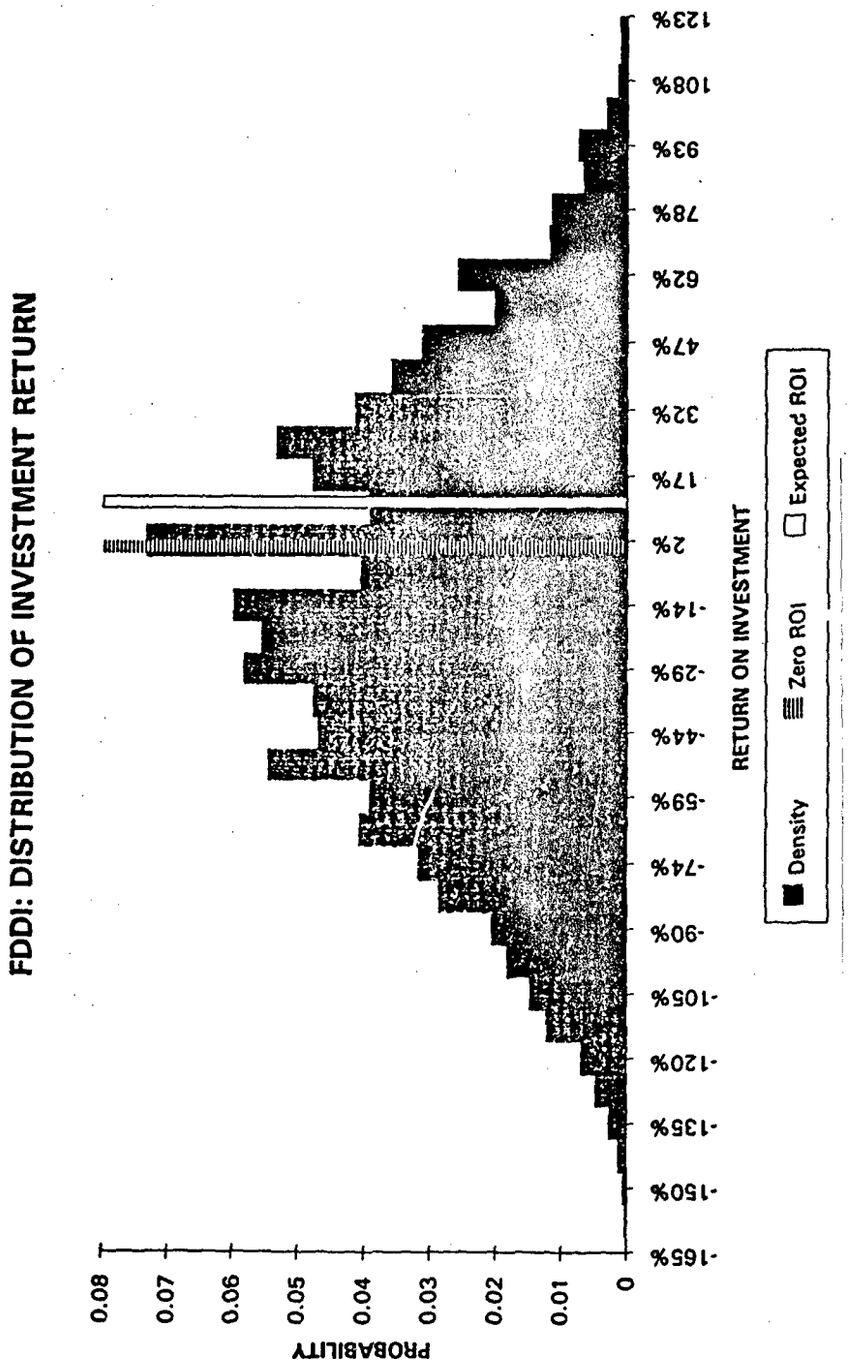
FDDI: DISTRIBUTION OF INVESTMENT RETURN
PROBABILITY
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
RETURN ON INVESTMENT
123%
108%
93%
78%
62%
47%
32%
17%
2%
-14%
-29%
-44%
-59%
-74%
-90%
-105%
-120%
-135%
-150%
-165%
Density
Zero ROI
Expected ROI

Exhibit 5-10

baseline and alternatives (20 values for the baseline and 20 values for the alternatives resulting in 400 total observations). The 400 points are then graphed in order to display the range of possible ROIs and their probabilities that can result from the alternative.

The expected ROI is identified in each exhibit. The single most important factor to consider when viewing and interpreting these probability distributions is the tendency of the distribution to skew around the expected value. Since the expected ROI is the value that was calculated from the most likely baseline and alternative costs, this ROI, or a ROI in a close range to this value, is likely to occur. If there is a large probability surrounding the expected value, then the decisionmaker can feel confident about using the calculated ROI to decide whether to invest.

Each of the distributions displays a zero ROI, the point where the investment pays for itself or "breaks even." This value helps to define the possibility of a negative return from the investment. In addition to the zero reference point, the high and low endpoints provide valuable information for the decisionmaker. Even though the probability associated with the high and low endpoints is small, these points identify the worst case scenario and the best case scenario for the decisionmaker.

In all three alternatives, there is a large probability surrounding the expected ROI, so the decisionmaker should feel confident that the expected ROI can be used in making the investment decision. The Ethernet alternative has the greatest ROI as well as the greatest probability (85 percent) of a positive ROI. The token ring alternative has the second highest ROI with a 75 percent probability of returning a positive ROI. The FDDI alternative provides the lowest ROI with a 66 percent probability of a negative ROI. The Ethernet alternative provides the best case scenario for an ROI, 499 percent, while the token ring provides the worst case scenario with a possibility for a -249 percent ROI.

5.3 Recommendations

This FEA performed for the DoD Finance function demonstrates the potential for significant benefits that can be realized through the adoption of new communications technologies. The selection of either the Ethernet or token ring LAN architectures can provide significant benefits that justify the investment costs. Both of these alternatives offer substantial benefits that pay back the investment funds within 4 years after the investment. The selection of the token ring alternative involves more risk, but offers slightly greater benefits to the Finance community.

Based on the results of this analysis, $2,528 per user can be invested to implement Ethernet LANs or $2,895 per user can be invested to implement the token ring LANs.

APPENDIXES

APPENDIX A

ACRONYM DEFINITIONS

Appendix A

ACRONYM DEFINITIONS

ANSI	American National Standards Institute
DISA	Defense Information Systems Agency
DITSO	Defense Information Technology Services Organization
DMRD	Defense Management Review Decision
DoD	Department of Defense
EDI	Electronic Data Interchange
EMI	Electromagnetic Interference
FDDI	Fiber Distributed Data Interface
FEA	Functional Economic Analysis
FY	Fiscal Year
GUI	Graphical User Interface
IT	Information Technology
LAN	Local Area Network
MB	Megabyte
Mbps	Megabits per Second
O&M	Operation and Maintenance
OSD(C)	Office of the Secretary of Defense (Comptroller)
OSE	Open Systems Environment
OSI	Open Systems Interconnection
PC	Personal Computer

RFI	Radio Frequency Interference
ROI	Return on Investment
STP	Shielded Twisted Pair
TCP/IP	Transmission Control Protocol/Internetwork Protocol
TEA	Technical Economic Analysis
UTP	Unshielded Twisted Pair

APPENDIX B

REFERENCES

Appendix B

REFERENCES

The following references were used in compiling this document:

Corporate Information Management Functional Economic Analysis Guidebook, 15 January 1993.

EDS Price List. EDS has negotiated prices for volume purchases of communications hardware and software.

Finance Communications Guidelines to the Defense Information Technology Services Organization, November 1992.

"Productivity Management." *Personal Computing*. Gartner Group, Inc. End-user computing has high investment costs, with potential benefits of 20 to 50 percent. Management of improved productivity is important, and job functions may change.

Small Multiuser Computer (SMC) Contract. 13600 EDS Drive, Herndon, Virginia 22071. (800) 762-3371 voice. The SMC contract includes networking software, but hardware only for Ethernet LANs. Training and engineering services are also available.

APPENDIX C

RECURRING COSTS

Appendix C

RECURRING COSTS

This appendix details the recurring costs associated with the baseline and for each of the three alternatives: Ethernet, token ring, and FDDI.

The recurring costs for the baseline and each of the three alternatives are categorized into personnel costs, IT hardware costs, IT software costs, IT operation and maintenance costs, and other costs. Costs are given for the base year, FY 1994, unless otherwise stated. Costs are not equal to the average cost per year across the life cycle, due to inflation.

C.1 Baseline

The technical baseline has recurring costs for personnel, hardware, software, and maintenance. There are no other costs associated with the baseline. These baseline costs are graphed in appendix E.

C.1.1 PERSONNEL

Baseline personnel costs are $3,370 per year for a typical Finance user whose annual salary and benefits are $42,190, the DoD composite compensation rate for civilians. This cost is based on a Gartner Group study that states that 8 percent of a user's time is spent on support tasks. Such support tasks include distributing data or messages to other users or waiting for information to arrive before processing it.

The Gartner Group found that as an aggregate, users without computers spent 17 percent of their time on management tasks, 54 percent on professional tasks, 8 percent on support tasks, 13 percent on clerical tasks, and 7 percent nonproductively. As an aggregate, users with computers spent 16 percent of their time on management tasks, 67 percent on professional tasks, 3 percent on support tasks, 7 percent on clerical tasks, and 7 percent nonproductively.

C.1.2 IT HARDWARE

In the baseline of point-to-point connections to host mainframes, both dial-in modems and direct cables exist to provide dedicated connections to the host computers. The hardware costs of these connections are sunk costs since the hardware already has been installed.

C.1.3 IT SOFTWARE

In the baseline of point-to-point connections to host mainframes, any software for accessing host computers has been installed. The existing 3270-type terminals do not require software to connect to host computers. The cost for the mainframe communications software is a sunk cost since the software has already been installed on the mainframe.

C.1.4 IT OPERATION AND MAINTENANCE

The point-to-point connections require annual maintenance or repairs worth $10 per year for proper functioning. This maintenance cost is based on a cable or modem valued at $100 and a 10 percent annual maintenance rate.

C.1.5 OTHER

The baseline has no other costs for the typical Finance user. The cost for training is a sunk cost, which typically is associated with the user's workstation and not the network.

C.2 Ethernet LAN

The Ethernet alternative affects recurring costs in personnel and hardware. Because no software costs are associated with the baseline, software costs are not affected. Recurring maintenance costs are eliminated. There are other training costs associated with the alternative. These recurring costs are plotted in appendix E.

C.2.1 PERSONNEL

The Ethernet alternative reduces personnel costs by 30 percent after 2 years. A study by the Gartner Group projects that such costs can be reduced by up to 60 percent. A benefit of 30 percent is realized because the Ethernet LAN allows the user to transfer data to other computers more efficiently. In addition, office automation software such as electronic mail allows a user to distribute data to other users quickly and efficiently. Finance users can access mainframe hosts through the LAN's router.

C.2.2 IT HARDWARE

The Ethernet alternative recovers $50 as the salvage value of the old point-to-point connection. The LAN replaces the dedicated connection, so the old connection can be sold. The salvage value of the old connection is 50 percent of the value of a new connection, which is worth $100.

C.2.3 IT SOFTWARE

The Ethernet alternative involves no software costs because the old connections had no associated software. The recurring costs for this alternative are plotted in appendix E.

C.2.4 IT OPERATION AND MAINTENANCE

The Ethernet alternative eliminates baseline maintenance costs because the LAN replaces the old connection.

C.2.5 OTHER

The Ethernet alternative increases other training costs by $340 (16 hours) per user the first year. An additional $177 (8 hours) in the second year are spent becoming familiar with the LAN and its software. Training costs are increased initially because the user must learn how to use the new software for the LAN. After the user has become familiar with the LAN and its software, the training cost returns to its original level.

C.3 Token Ring LAN

The token ring alternative affects recurring costs in personnel and hardware. Because no software costs are associated with the baseline, software costs are not affected. Recurring maintenance costs are eliminated. There are other training costs associated with the alternative.

C.3.1 PERSONNEL

The token ring alternative reduces personnel costs by 32.5 percent after 2 years. Token ring produces somewhat greater benefits than Ethernet because it is 60 percent faster. A study by the Gartner Group projects that such costs can be reduced by 60 percent. This benefit is realized because the LAN allows the user to transfer data to other users more efficiently. In addition, office automation software such as electronic mail allows a user to distribute data quickly and efficiently. Finance users can access mainframe hosts through the LAN's router.

C.3.2 IT HARDWARE

The token ring alternative recovers $50 as the salvage value of the old point-to-point connection. The LAN replaces the dedicated connection, so the old connection can be sold. The salvage value of the old connection is 50 percent of the value of a new connection, which is worth $100.

C.3.3 IT SOFTWARE

The token ring alternative involves no software costs because the old connections had no associated software.

C.3.4 IT OPERATION AND MAINTENANCE

The token ring alternative eliminates baseline maintenance costs because the LAN replaces the old connection.

C.3.5 OTHER

The token ring alternative increases other training costs by $340 (16 hours) per user the first year. An additional $177 (8 hours) in the second year are spent becoming familiar with the LAN and its software. Training costs are increased initially because the user must learn how to use the new software for the LAN. After the user has become familiar with the LAN and its software, the training cost returns to its original level.

C.4 FDDI LAN

The FDDI alternative affects recurring costs in personnel and hardware. Because no software costs are associated with the baseline, software costs are not affected. Recurring maintenance costs are eliminated. There are other training costs associated with the alternative.

C.4.1 PERSONNEL

The FDDI alternative reduces personnel costs by 40 percent after 2 years. The FDDI alternative has greater benefits than Ethernet or token ring because it is more reliable and 6 to 10 times faster than either of the other alternatives. A study by the Gartner Group projects that such costs can be reduced by 60 percent. This benefit is realized because the FDDI alternative allows the user to transfer data to other users more efficiently. In addition, office automation software such as electronic mail allows a user to distribute data quickly and easily. Finance users can access mainframe hosts through the LAN's router. The high speed and bandwidth of FDDI supports multimedia applications, imaging, and other high-bandwidth applications.

C.4.2 IT HARDWARE

The FDDI alternative recovers $50 as the salvage value of the old point-to-point connection. The LAN replaces the dedicated connection, so the old connection can be sold. The salvage value of the old connection is 50 percent of the value of a new connection, which is worth $100.

C.4.3 IT SOFTWARE

The FDDI alternative involves no software costs because the old connections had no associated software.

C.4.4 IT OPERATION AND MAINTENANCE

The FDDI alternative eliminates baseline maintenance costs because the LAN replaces the old connection.

C.4.5 OTHER

The FDDI alternative increases other training costs by $340 (16 hours) per user the first year. An additional $177 (8 hours) are spent in the second year becoming familiar with the LAN and its software. Training costs are increased initially because the user must learn how to use the new software for the LAN. After the user has become familiar with the LAN and its software, the training cost returns to its original level.

APPENDIX D

INVESTMENT COSTS

Appendix D

INVESTMENT COSTS

This appendix details the investment costs associated with each of the three alternatives: Ethernet, token ring, and FDDI.

The investment costs for each of the three alternatives are categorized into IT hardware costs, IT software costs, and IT operation and maintenance costs.

In addition to the per-user costs associated with each workstation, additional costs are associated with each workgroup or site. Each of the LAN alternatives requires common connecting hardware such as wiring hubs, bridges, and routers. The actual price and number vary widely depending on the number and type of connections needed. Wiring hubs simplify network maintenance through centralized connection points. Routers and bridges allow the LAN to interface with mainframes or other LANs.

User sites are assumed to have 24 people. The median number of Finance users at an individual site in the Defense Management Review Decision (DMRD) 910 estimate is 26 people. A somewhat smaller number of users (24) is taken to be the nominal workgroup size in order to be conservative in distributing site costs among users. Costs are given for the base year, FY 1994. Costs are not equal to the average cost per year across the life cycle, due to inflation.

D.1 Ethernet

The Ethernet alternative requires investment in hardware, software, and ongoing maintenance or repairs. These investment costs for hardware and software were drawn from EDS contracts and are representative prices for comparison purposes. These costs are graphed in appendix E.

D.1.1 IT HARDWARE

The Ethernet alternative requires investment in hardware to connect the user to the network. Each user requires an Ethernet network interface card costing $166, network interface software costing $72, and 200 feet of wire that costs $98. In addition, 2 hours of labor are required to install and configure the hardware for the user. The installer is paid at an hourly rate of $14.13, the DoD composite compensation rate for enlisted personnel.

Each site requires the following at the wiring hub:

• Enclosure	$ 726
• Power supply	910
• Twenty-four-port wiring hub	2,574

• Module manager	$4,500
• Ten hours of labor running cable	141

Each site requires the following at the router:

• Router	$7,704
• Ethernet interface	4,063
• Bridge	929
• Serial interface	215
• v.35 port	107
• v.35 cable	72
• Twenty hours of labor to configure the router	283

D.1.2 IT SOFTWARE

The Ethernet alternative requires electronic mail and networking software to connect the user to the network. The user's electronic mail software costs $100 per user and the network software costs $200 per user.

D.1.3 IT OPERATION AND MAINTENANCE

Each user's Ethernet card and connection require $25 in annual maintenance or repairs. In addition, each user has a $95 share of the maintenance of the hub and router. These maintenance costs are based on a 10 percent annual maintenance rate for the installed hardware.

D.2 Token Ring

The token ring alternative requires investment in hardware, software, and ongoing maintenance or repairs. The costs listed below are from EDS contracts and are representative prices for comparison purposes. These investment costs are graphed in appendix E.

D.2.1 IT HARDWARE

The token ring alternative requires more investment than the Ethernet alternative, since the network cards are more expensive. The costs for token ring connections are decreasing and will be more in line with those for the Ethernet alternative after 6 months.

The token ring alternative requires investment in hardware to connect the user to the network. Each user requires a network interface card costing $381, network interface software costing $72, and 200 feet of wire for $98. In addition, 2 hours of labor are required to install and

configure the hardware for the user. The installer is paid at an hourly rate of $14.13, the DoD composite compensation rate for enlisted personnel.

Each site requires the following at the wiring hub:

• Enclosure	$ 726
• Power supply	910
• Twenty-four-port wiring hub	2,266
• Module manager	4,500
• Ten hours of labor running cable	141

Each site requires the following at the router:

• Router	$7,704
• Token ring interface	4,260
• Bridge	929
• Serial interface	215
• v.35 port	107
• v.35 cable	72
• Twenty hours of labor configuring the router	283

D.2.2 IT SOFTWARE

The token ring alternative requires electronic mail and networking software to connect the user to the network. Each user's electronic mail software costs $100 per user and the network software costs $200 per user.

D.2.3 IT OPERATION AND MAINTENANCE

Each user's token ring card and connection require annual maintenance or repairs (at a $45 cost) for proper functioning. In addition, each user incurs a $95 share of the maintenance of the hub and router. These maintenance costs are based on a 10 percent annual maintenance rate for the installed hardware.

D.3 FDDI

The FDDI alternative requires investment in hardware, software, and ongoing maintenance or repairs. These investment costs are drawn from the SMC contract and are representative prices for comparison purposes. The investment costs for this alternative are graphed in appendix E.

D.3.1 IT HARDWARE

The FDDI alternative requires a significantly higher investment than the Ethernet or token ring alternatives, since the network cards and wiring hubs are significantly more expensive. The costs for FDDI connections are decreasing rapidly and will have decreased by about 50 percent after 6 months.

The FDDI alternative requires investment in hardware to connect the user to the network. Each user requires a network interface card for $995, network interface software costing $72, and 200 feet of wire for $140. In addition, 2 hours of labor are required to install and configure the hardware for the user. The installer is paid at an hourly rate of $14.13, the DoD composite compensation rate for enlisted personnel.

Each site requires the following at the wiring hub:

• Enclosure	$ 726
• Power supply	910
• Three 8-port wiring hubs (at $11,125 each)	33,375
• Bridge	929
• Module manager	11,625
• Ten hours of labor running cable	141

Each site requires the following at the router:

• Router	$7,704
• FDDI interface	5,964
• Serial interface	215
• v.35 port	107
• v.35 cable	72
• Twenty hours of labor configuring the router	283

Three 8-port wiring hubs are required to support 24 users; a 24-port wiring hub is not available.

D.3.2 IT SOFTWARE

The FDDI alternative requires electronic mail and networking software to connect the user to the network. Each user's electronic mail software costs $100 per user and the network software costs $200 per user.

D.3.3 IT OPERATION AND MAINTENANCE

Each user's FDDI card and connection require annual maintenance or repairs worth $116 for proper functioning. In addition, each user has a $254 share of the maintenance of the hub and router. These maintenance costs are based on a 10 percent annual maintenance rate for the installed hardware.

APPENDIX E

SUPPORTING EXHIBITS

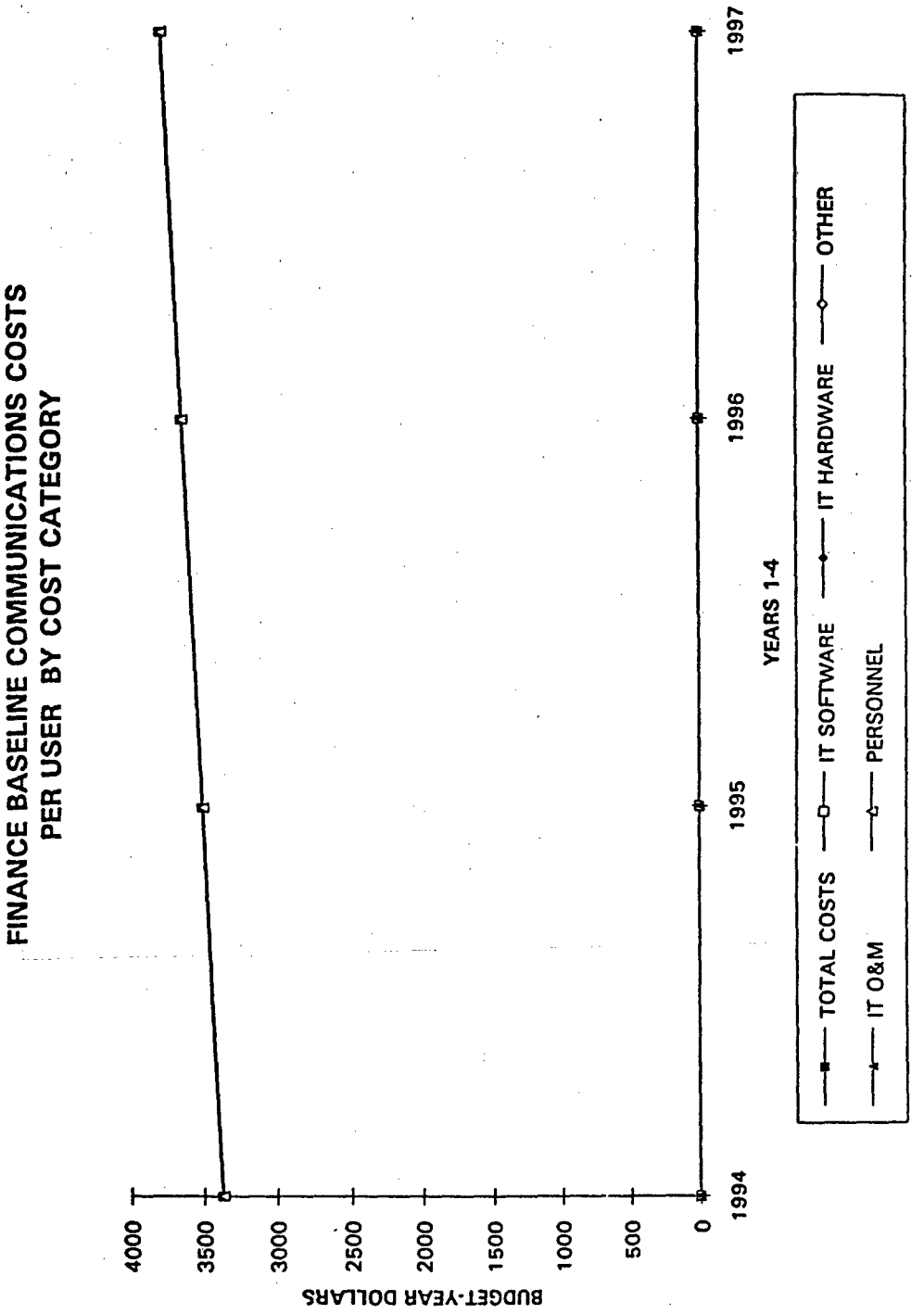
FINANCE BASELINE COMMUNICATIONS COSTS
PER USER BY COST CATEGORY
BUDGET-YEAR DOLLARS
4000
3500
3000
2500
2000
1500
1000
500
0
1994
1995
1996
1997
YEARS 1-4
TOTAL COSTS
IT SOFTWARE
IT HARDWARE
OTHER
IT O&M
PERSONNEL

Exhibit E-1

TOTAL BASELINE COMMUNICATIONS COSTS
(BUDGET-YEAR DOLLARS)

COST CATEGORY		Year 1 1994	Year 2 1995	Year 3 1996	Year 4 1997	RESIDUAL 1998-2000	TOTAL 1994-2000
Recurring							
Personnel	Low	3,033.0	3,152.8	3,277.3	3,406.8	11,049.3	23,919.2
	Expected	3,370.0	3,503.1	3,641.5	3,785.3	12,277.0	26,576.9
	High	4,094.6	4,256.3	4,424.4	4,599.2	14,916.5	32,291.0
IT Hardware	Low	0.0	0.0	0.0	0.0	0.0	0.0
	Expected	0.0	0.0	0.0	0.0	0.0	0.0
	High	0.0	0.0	0.0	0.0	0.0	0.0
IT Software	Low	0.0	0.0	0.0	0.0	0.0	0.0
	Expected	0.0	0.0	0.0	0.0	0.0	0.0
	High	0.0	0.0	0.0	0.0	0.0	0.0
IT O&M	Low	9.0	9.3	9.7	10.0	32.3	70.4
	Expected	10.0	10.4	10.7	11.1	35.9	78.2
	High	12.2	12.6	13.1	13.5	43.7	95.0
Other	Low	0.0	0.0	0.0	0.0	0.0	0.0
	Expected	0.0	0.0	0.0	0.0	0.0	0.0
	High	0.0	0.0	0.0	0.0	0.0	0.0
Total Recurring Costs	Low	3,042.0	3,162.1	3,287.0	3,416.8	11,081.6	23,989.6
	Expected	3,380.0	3,513.5	3,652.2	3,796.5	12,312.9	26,655.1
	High	4,106.7	4,268.9	4,437.5	4,612.7	14,960.2	32,386.0
Investment							
IT Hardware	Low	0.0	0.0	0.0	0.0	0.0	0.0
	Expected	0.0	0.0	0.0	0.0	0.0	0.0
	High	0.0	0.0	0.0	0.0	0.0	0.0
IT Software	Low	0.0	0.0	0.0	0.0	0.0	0.0
	Expected	0.0	0.0	0.0	0.0	0.0	0.0
	High	0.0	0.0	0.0	0.0	0.0	0.0
IT O&M	Low	0.0	0.0	0.0	0.0	0.0	0.0
	Expected	0.0	0.0	0.0	0.0	0.0	0.0
	High	0.0	0.0	0.0	0.0	0.0	0.0
Total Investment Costs	Low	0.0	0.0	0.0	0.0	0.0	0.0
	Expected	0.0	0.0	0.0	0.0	0.0	0.0
	High	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL COST	Low	3,042.0	3,162.1	3,287.0	3,416.8	11,081.6	23,989.6
	Expected	3,380.0	3,513.5	3,652.2	3,796.5	12,312.9	26,655.1
	High	4,106.7	4,268.9	4,437.5	4,612.7	14,960.2	32,386.0
BASELINE COST	Low	3,042.0	3,162.1	3,287.0	3,416.8	11,081.6	23,989.6
	Expected	3,380.0	3,513.5	3,652.2	3,796.5	12,312.9	26,655.1
	High	4,106.7	4,268.9	4,437.5	4,612.7	14,960.2	32,386.0

(Totals may not be exact due to rounding)

Exhibit E-2

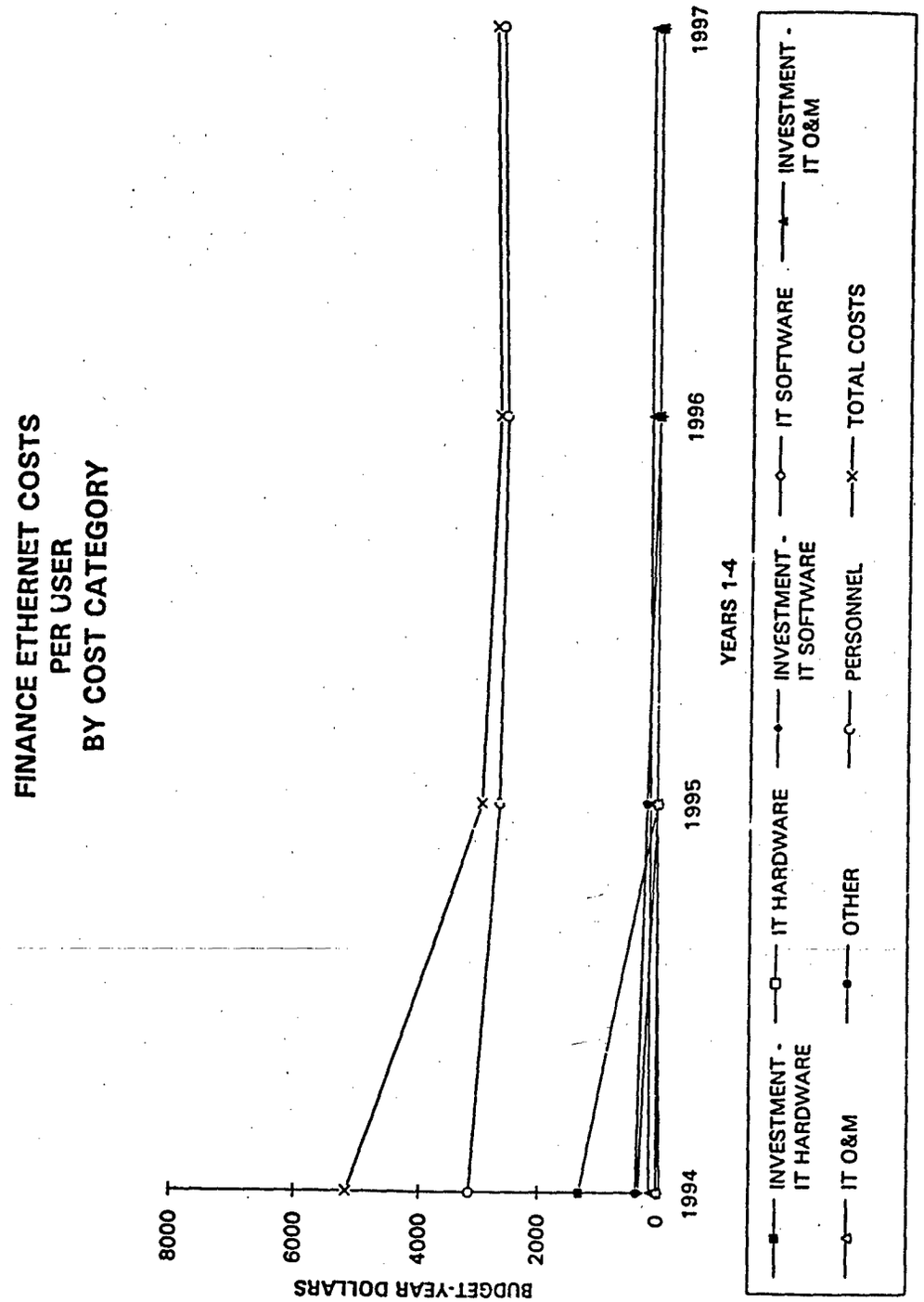
FINANCE ETHERNET COSTS
PER USER
BY COST CATEGORY
BUDGET-YEAR DOLLARS
8000
6000
4000
2000
0
1994
1995
1996
1997
YEARS 1-4
INVESTMENT - IT HARDWARE
IT HARDWARE
INVESTMENT - IT SOFTWARE
IT SOFTWARE
INVESTMENT - IT O&M
IT O&M
OTHER
PERSONNEL
TOTAL COSTS

Exhibit E-3

TOTAL COSTS
ALTERNATIVE ONE: ETHERNET
(BUDGET-YEAR DOLLARS)

COST CATEGORY		Year 1 1994	Year 2 1995	Year 3 1996	Year 4 1997	RESIDUAL 1998-2000	TOTAL 1994-1999
Recurring							
	Low	2,853.0	2,395.0	2,295.1	2,385.8	7,737.8	17,666.7
Personnel	Expected	3,170.0	2,661.1	2,550.1	2,650.9	8,597.5	19,629.6
	High	4,533.1	3,805.4	3,646.7	3,790.7	12,294.5	28,070.4
	Low	-45.0	0.0	0.0	0.0	0.0	-45.0
IT Hardware	Expected	-50.0	0.0	0.0	0.0	0.0	-50.0
	High	-71.5	0.0	0.0	0.0	0.0	-71.5
	Low	0.0	0.0	0.0	0.0	0.0	0.0
IT Software	Expected	0.0	0.0	0.0	0.0	0.0	0.0
	High	0.0	0.0	0.0	0.0	0.0	0.0
	Low	0.0	0.0	0.0	0.0	0.0	0.0
IT O&M	Expected	0.0	0.0	0.0	0.0	0.0	0.0
	High	0.0	0.0	0.0	0.0	0.0	0.0
	Low	306.0	159.0	0.0	0.0	0.0	465.0
Other	Expected	340.0	176.7	0.0	0.0	0.0	516.7
	High	486.2	252.7	0.0	0.0	0.0	738.9
Total	Low	3,114.0	2,554.1	2,295.1	2,385.8	7,737.8	18,086.7
Recurring Costs	Expected	3,460.0	2,837.8	2,550.1	2,650.9	8,597.5	20,096.4
	High	4,947.8	4,058.1	3,646.7	3,790.7	12,294.5	28,737.8
Investment							
	Low	1,161.0	0.0	0.0	0.0	0.0	1161.0
IT Hardware	Expected	1,290.0	0.0	0.0	0.0	0.0	1290.0
	High	1,844.7	0.0	0.0	0.0	0.0	1844.7
	Low	270.0	0.0	0.0	0.0	0.0	270.0
IT Software	Expected	300.0	0.0	0.0	0.0	0.0	300.0
	High	429.0	0.0	0.0	0.0	0.0	429.0
	Low	108.0	112.0	116.1	120.3	388.0	844.4
IT O&M	Expected	120.0	124.4	129.0	133.7	431.1	938.2
	High	171.6	177.9	184.4	191.2	616.5	1341.6
Total	Low	1539.0	112.0	116.1	120.3	388.0	2275.4
Investment Costs	Expected	1710.0	124.4	129.0	133.7	431.1	2528.2
	High	2445.3	177.9	184.4	191.2	616.5	3615.3
	Low	4,653.0	2,666.0	2,411.2	2,506.1	8,125.8	20,362.1
TOTAL COST	Expected	5,170.0	2,962.2	2,679.1	2,784.5	9,028.7	22,624.5
	High	7,393.1	4,236.0	3,831.1	3,981.9	12,911.0	32,353.1
	Low	3,042.0	3,162.1	3,287.0	3,416.8	11,081.6	23,989.6
BASELINE COST	Expected	3,380.0	3,513.5	3,652.2	3,796.5	12,312.9	26,655.1
	High	4,106.7	4,268.9	4,437.5	4,612.7	14,960.2	32,386.0
BENEFITS	Expected	-1,790.0	551.3	973.2	1,011.9	3,284.2	4,030.6
CUMULATIVE BENEFITS	Expected	-1,790.0	-1,238.7	-265.6	746.3	4,030.6	

(Totals may not be exact due to rounding)

Exhibit E-4

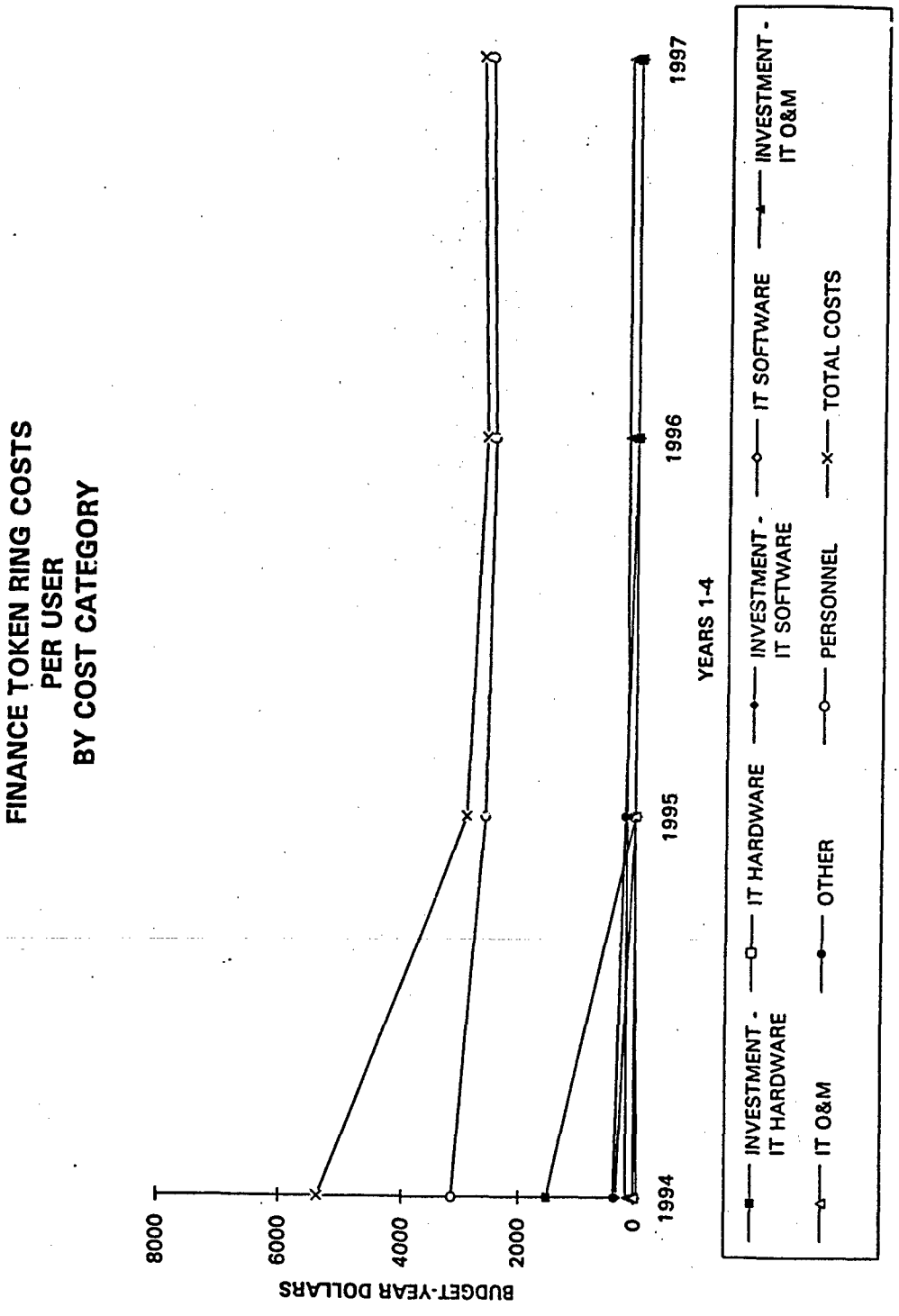
FINANCE TOKEN RING COSTS
PER USER
BY COST CATEGORY
BUDGET-YEAR DOLLARS
8000
6000
4000
2000
0
1994
1995
1996
1997
YEARS 1-4
INVESTMENT - IT HARDWARE
IT HARDWARE
INVESTMENT - IT SOFTWARE
IT SOFTWARE
INVESTMENT - IT O&M
IT O&M
OTHER
PERSONNEL
TOTAL COSTS

Exhibit E-5

TOTAL COSTS
ALTERNATIVE TWO: TOKEN RING
(BUDGET-YEAR DOLLARS)

COST CATEGORY		Year 1 1994	Year 2 1995	Year 3 1996	Year 4 1997	RESIDUAL 1998-2000	TOTAL 1994-1999
Recurring							
Personnel	Low	2,835.0	2,328.5	2,207.6	2,294.8	7,442.7	17,109.6
	Expected	3,150.0	2,588.4	2,452.8	2,549.8	8,269.7	19,010.7
	High	5,181.8	4,257.8	4,035.0	4,194.4	13,603.6	31,272.5
IT Hardware	Low	-45.0	0.0	0.0	0.0	0.0	-45.0
	Expected	-50.0	0.0	0.0	0.0	0.0	-50.0
	High	-82.3	0.0	0.0	0.0	0.0	-82.3
IT Software	Low	0.0	0.0	0.0	0.0	0.0	0.0
	Expected	0.0	0.0	0.0	0.0	0.0	0.0
	High	0.0	0.0	0.0	0.0	0.0	0.0
IT O&M	Low	0.0	0.0	0.0	0.0	0.0	0.0
	Expected	0.0	0.0	0.0	0.0	0.0	0.0
	High	0.0	0.0	0.0	0.0	0.0	0.0
Other	Low	306.0	159.0	0.0	0.0	0.0	465.0
	Expected	340.0	176.7	0.0	0.0	0.0	516.7
	High	559.3	290.7	0.0	0.0	0.0	850.0
Total Recurring Costs	Low	3,096.0	2,488.6	2,207.6	2,294.8	7,442.7	17,529.6
	Expected	3,440.0	2,765.1	2,452.8	2,549.8	8,269.7	19,477.4
	High	5,658.8	4,548.5	4,035.0	4,194.4	13,603.6	32,040.3
Investment							
IT Hardware	Low	1,350.0	0.0	0.0	0.0	0.0	1350.0
	Expected	1,500.0	0.0	0.0	0.0	0.0	1500.0
	High	2,467.5	0.0	0.0	0.0	0.0	2467.5
IT Software	Low	270.0	0.0	0.0	0.0	0.0	270.0
	Expected	300.0	0.0	0.0	0.0	0.0	300.0
	High	493.5	0.0	0.0	0.0	0.0	493.5
IT O&M	Low	126.0	130.6	135.4	140.4	452.7	985.1
	Expected	140.0	145.1	150.4	156.0	503.0	1094.5
	High	230.3	238.7	247.5	256.6	827.4	1800.5
Total Investment Costs	Low	1746.0	130.6	135.4	140.4	452.7	2605.1
	Expected	1940.0	145.1	150.4	156.0	503.0	2894.5
	High	3191.3	238.7	247.5	256.6	827.4	4761.5
TOTAL COST	Low	4,842.0	2,619.2	2,343.0	2,435.1	7,895.4	20,134.7
	Expected	5,380.0	2,910.2	2,603.3	2,705.7	8,772.7	22,371.9
	High	8,850.1	4,787.3	4,282.5	4,450.9	14,431.0	36,801.8
BASELINE COST	Low	3,042.0	3,162.1	3,287.0	3,416.8	11,081.6	23,989.6
	Expected	3,380.0	3,513.5	3,652.2	3,796.5	12,312.9	26,655.1
	High	4,106.7	4,268.9	4,437.5	4,612.7	14,960.2	32,386.0
BENEFITS	Expected	-2,000.0	603.3	1,048.9	1,090.8	3,540.3	4,283.2
CUMULATIVE BENEFITS	Expected	-2,000.0	-1,396.7	-347.8	743.0	4,283.2	

(Totals may not be exact due to rounding)

Exhibit E-6

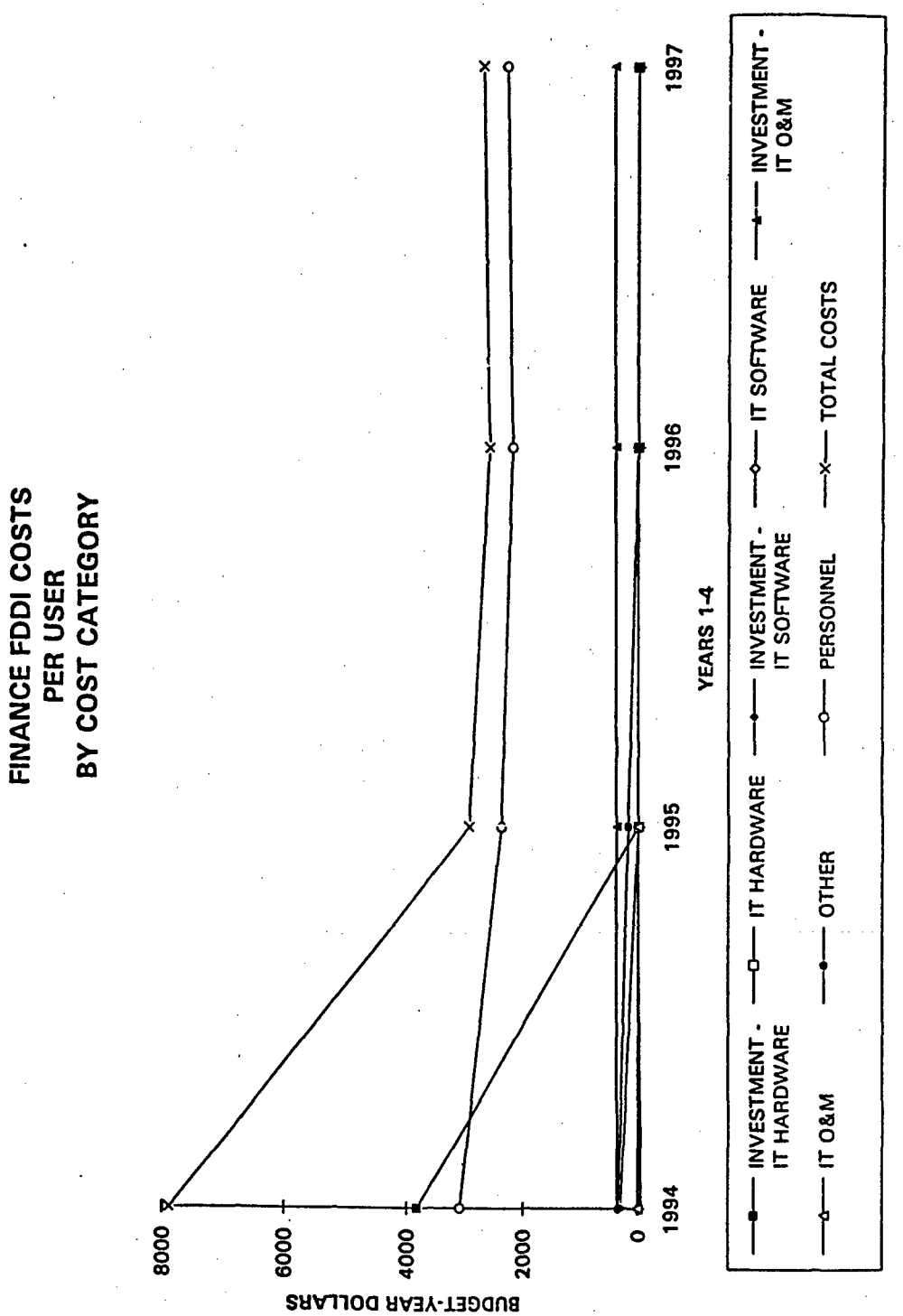
FINANCE FDDI COSTS
PER USER
BY COST CATEGORY
BUDGET-YEAR DOLLARS
8000
6000
4000
2000
0
1994
1995
1996
1997
YEARS 1-4
INVESTMENT - IT HARDWARE
IT HARDWARE
INVESTMENT - IT SOFTWARE
IT SOFTWARE
INVESTMENT - IT O&M
IT O&M
OTHER
PERSONNEL
TOTAL COSTS

Exhibit E-7

TOTAL COSTS
ALTERNATIVE THREE: FDDI
(BUDGET-YEAR DOLLARS)

COST CATEGORY		Year 1 1994	Year 2 1995	Year 3 1996	Year 4 1997	RESIDUAL 1998-2000	TOTAL 1994-2000
Recurring							
Personnel	Low	2,780.0	2,142.4	1,964.5	2,042.1	6,623.0	15,561.9
	Expected	3,100.0	2,380.5	2,182.7	2,269.0	7,358.9	17,291.1
	High	5,766.0	4,427.8	4,059.9	4,220.3	13,687.6	32,161.4
IT Hardware	Low	-45.0	0.0	0.0	0.0	0.0	-45.0
	Expected	-50.0	0.0	0.0	0.0	0.0	-50.0
	High	-93.0	0.0	0.0	0.0	0.0	-93.0
IT Software	Low	0.0	0.0	0.0	0.0	0.0	0.0
	Expected	0.0	0.0	0.0	0.0	0.0	0.0
	High	0.0	0.0	0.0	0.0	0.0	0.0
IT O&M	Low	0.0	0.0	0.0	0.0	0.0	0.0
	Expected	0.0	0.0	0.0	0.0	0.0	0.0
	High	0.0	0.0	0.0	0.0	0.0	0.0
Other	Low	306.0	159.0	0.0	0.0	0.0	465.0
	Expected	340.0	176.7	0.0	0.0	0.0	516.7
	High	632.4	328.7	0.0	0.0	0.0	961.1
Total Recurring Costs	Low	3,051.0	2,301.5	1,964.5	2,042.1	6,623.0	15,982.0
	Expected	3,390.0	2,557.2	2,182.7	2,269.0	7,358.9	17,757.8
	High	6,305.4	4,756.3	4,059.9	4,220.3	13,687.6	33,029.4
Investment							
IT Hardware	Low	3,438.0	0.0	0.0	0.0	0.0	3438.0
	Expected	3,820.0	0.0	0.0	0.0	0.0	3820.0
	High	7,105.2	0.0	0.0	0.0	0.0	7105.2
IT Software	Low	270.0	0.0	0.0	0.0	0.0	270.0
	Expected	300.0	0.0	0.0	0.0	0.0	300.0
	High	558.0	0.0	0.0	0.0	0.0	558.0
IT O&M	Low	333.0	345.2	357.8	371.0	1,196.4	2603.4
	Expected	370.0	383.6	397.6	412.2	1,329.4	2892.7
	High	688.2	713.4	739.5	766.6	2,472.6	5380.4
Total Investment Costs	Low	4041.0	345.2	357.8	371.0	1196.4	6311.4
	Expected	4490.0	383.6	397.6	412.2	1329.4	7012.7
	High	8351.4	713.4	739.5	766.6	2472.6	13043.6
TOTAL COST	Low	7,092.0	2,646.7	2,322.3	2,413.0	7,819.4	22,293.4
	Expected	7,880.0	2,940.7	2,580.3	2,681.1	8,688.3	24,770.5
	High	14,656.8	5,469.8	4,799.4	4,986.9	16,160.2	46,073.1
BASELINE COST	Low	3,042.0	3,162.1	3,287.0	3,416.8	11,081.6	23,989.6
	Expected	3,380.0	3,513.5	3,652.2	3,796.5	12,312.9	26,655.1
	High	4,106.7	4,268.9	4,437.5	4,612.7	14,960.2	32,386.0
BENEFITS	Expected	-4,500.0	572.8	1,071.9	1,115.3	3,624.7	1,884.7
CUMULATIVE BENEFITS	Expected	-4,500.0	-3,927.2	-2,855.3	-1,740.0	1,884.7	

(Totals may not be exact due to rounding)

Exhibit E-8

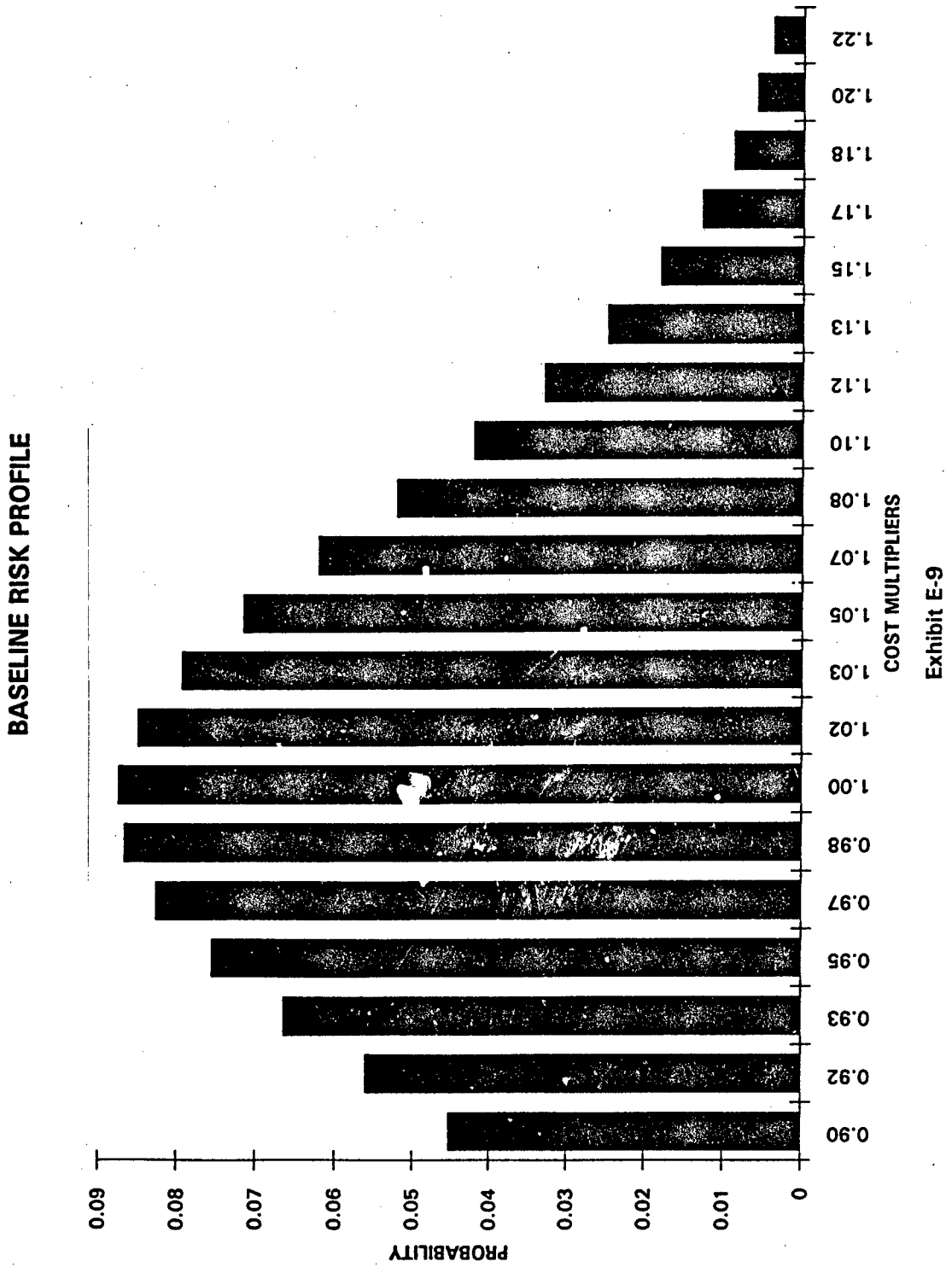
BASELINE RISK PROFILE
PROBABILITY
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
COST MULTIPLIERS
0.90
0.92
0.93
0.95
0.97
0.98
1.00
1.02
1.03
1.05
1.07
1.08
1.10
1.12
1.13
1.15
1.17
1.18
1.20
1.22

Exhibit E-9

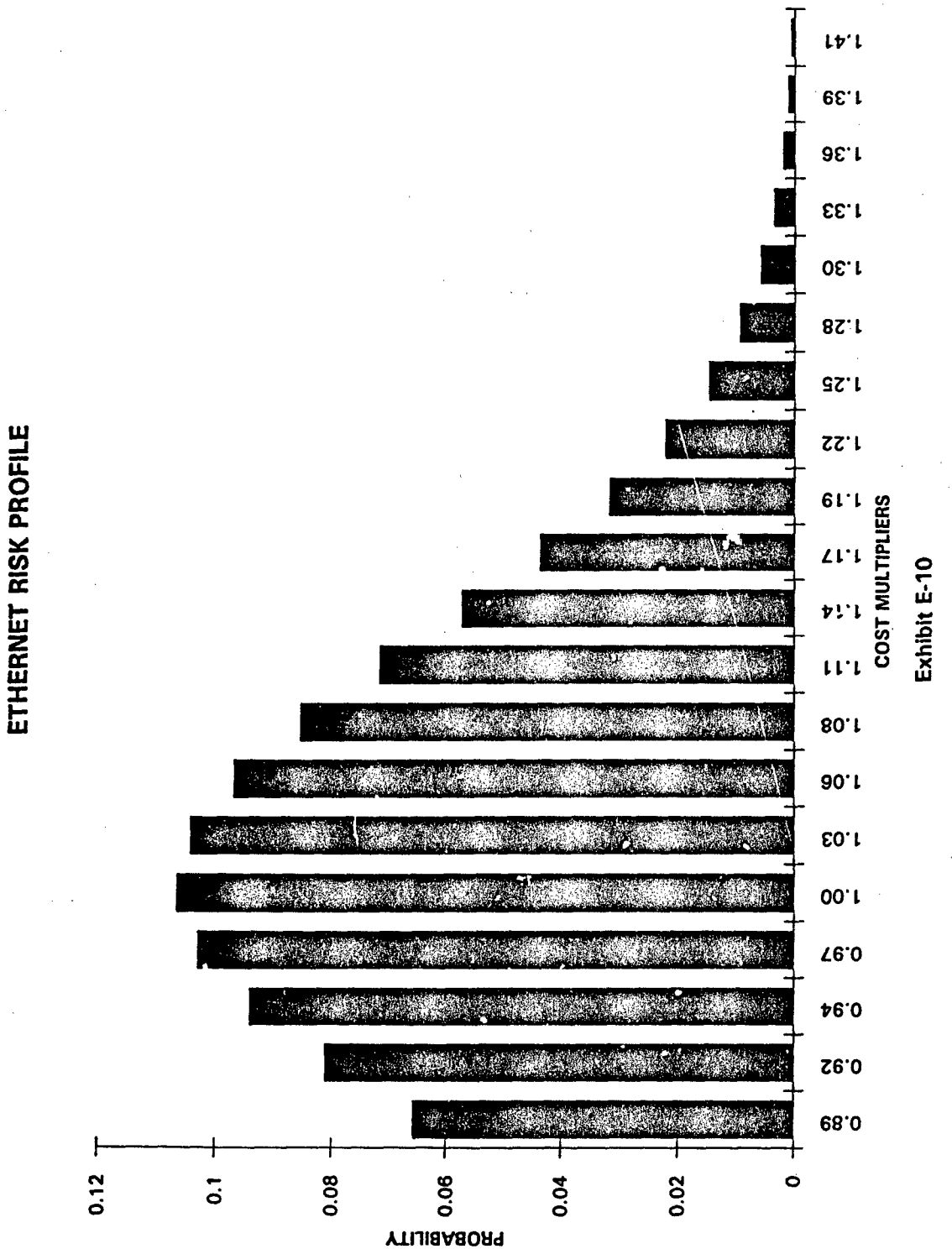
ETHERNET RISK PROFILE
PROBABILITY
0.12
0.1
0.08
0.06
0.04
0.02
0
COST MULTIPLIERS
0.89
0.92
0.94
0.97
1.00
1.03
1.06
1.08
1.11
1.14
1.17
1.19
1.22
1.25
1.28
1.30
1.33
1.36
1.39
1.41

Exhibit E-10

TOKEN RING RISK PROFILE

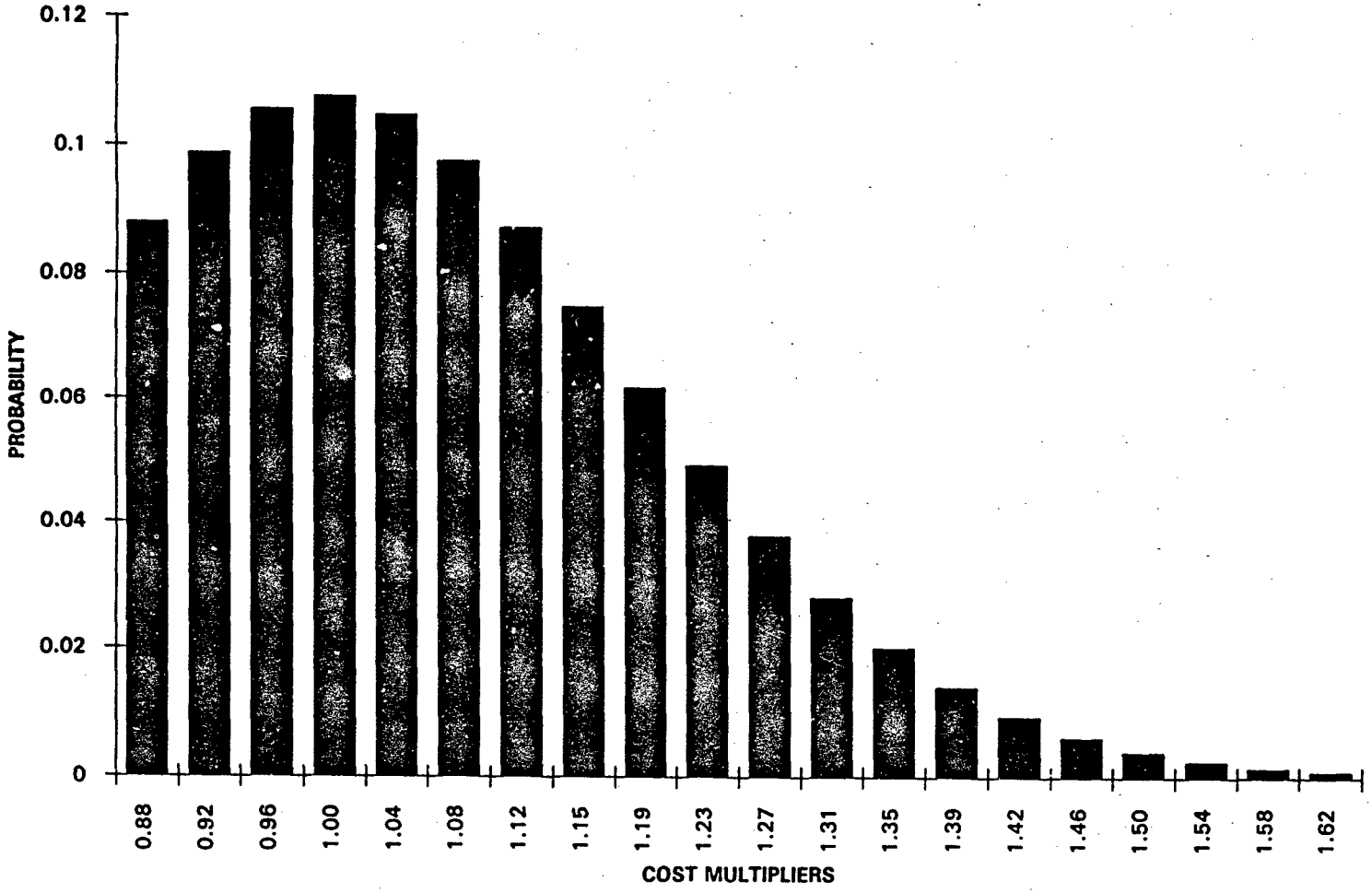

Exhibit E-11

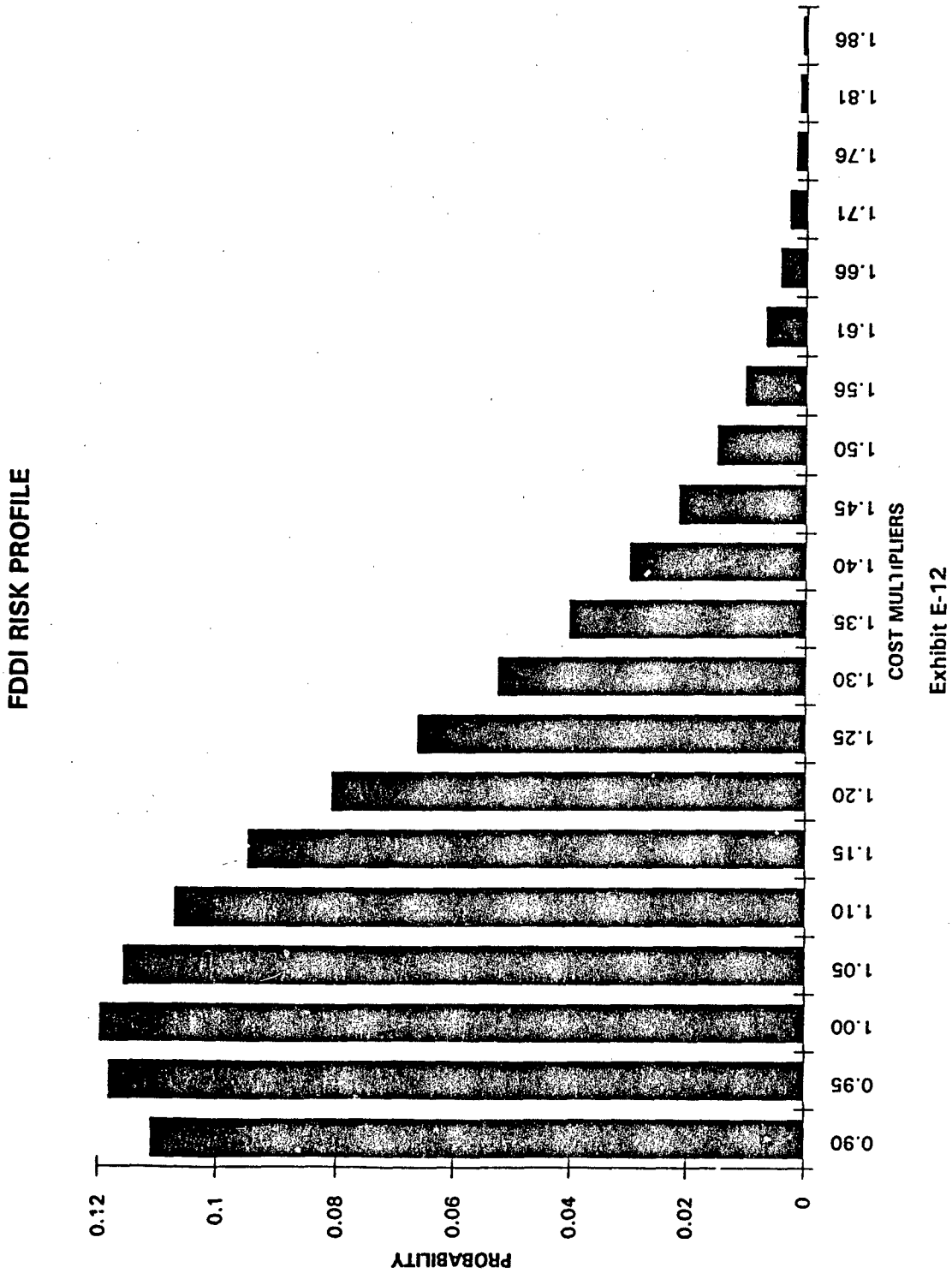
FDDI RISK PROFILE
PROBABILITY
0.12
0.1
0.08
0.06
0.04
0.02
0
COST MULTIPLIERS
0.90
0.95
1.00
1.05
1.10
1.15
1.20
1.25
1.30
1.35
1.40
1.45
1.50
1.56
1.61
1.66
1.71
1.76
1.81
1.86

Exhibit E-12